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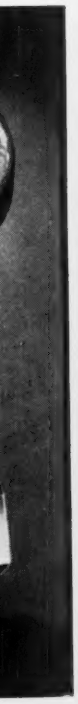

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Magazine

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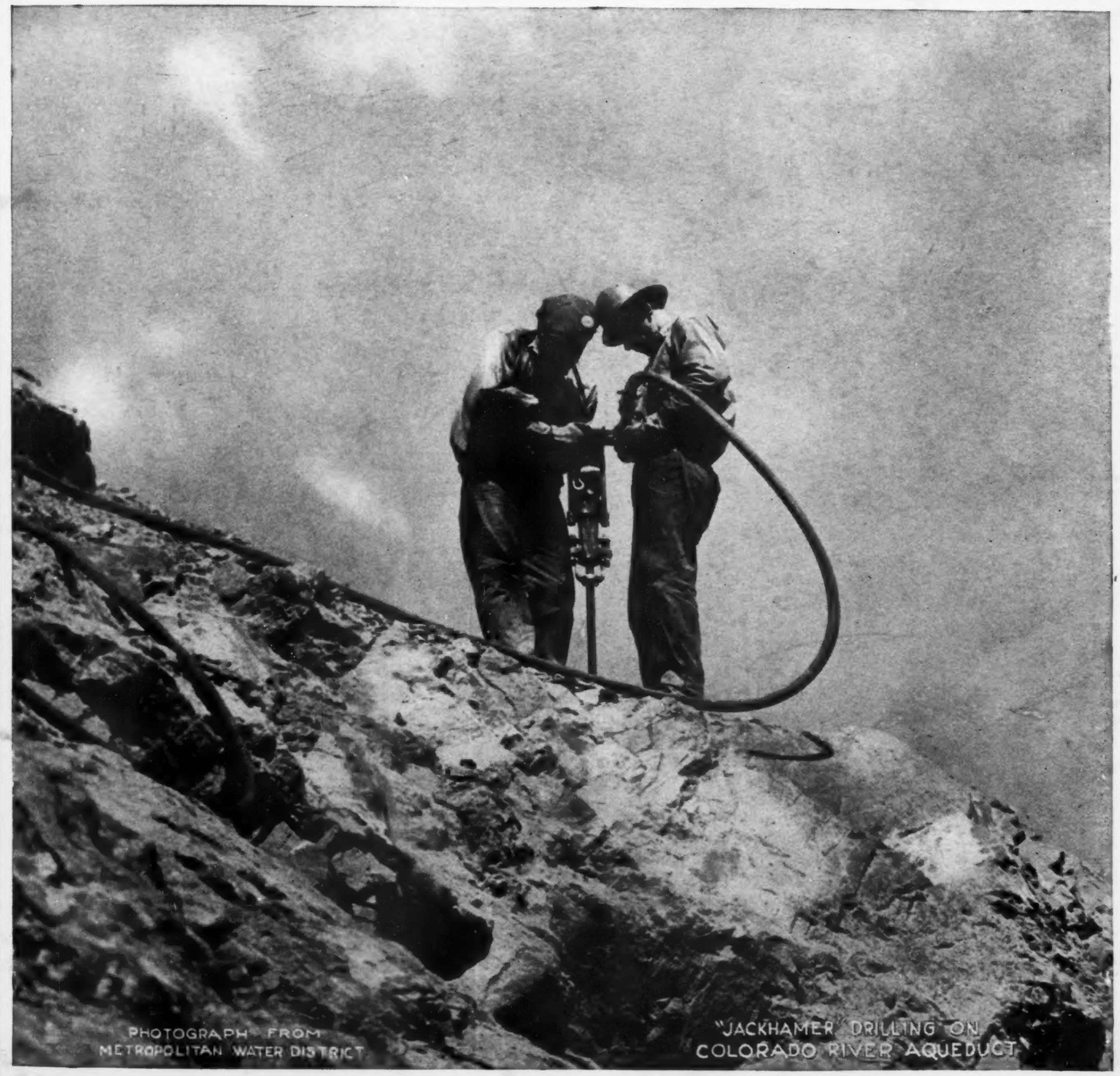

PHOTOGRAPH FROM METROPOLITAN WATER DISTRICT

"JACKHAMER" DRILLING ON COLORADO RIVER AQUEDUCT

A Monthly Publication Devoted to the Many Fields of Endeavor in which Compressed Air Serves Useful Purposes

FOUNDED 1896

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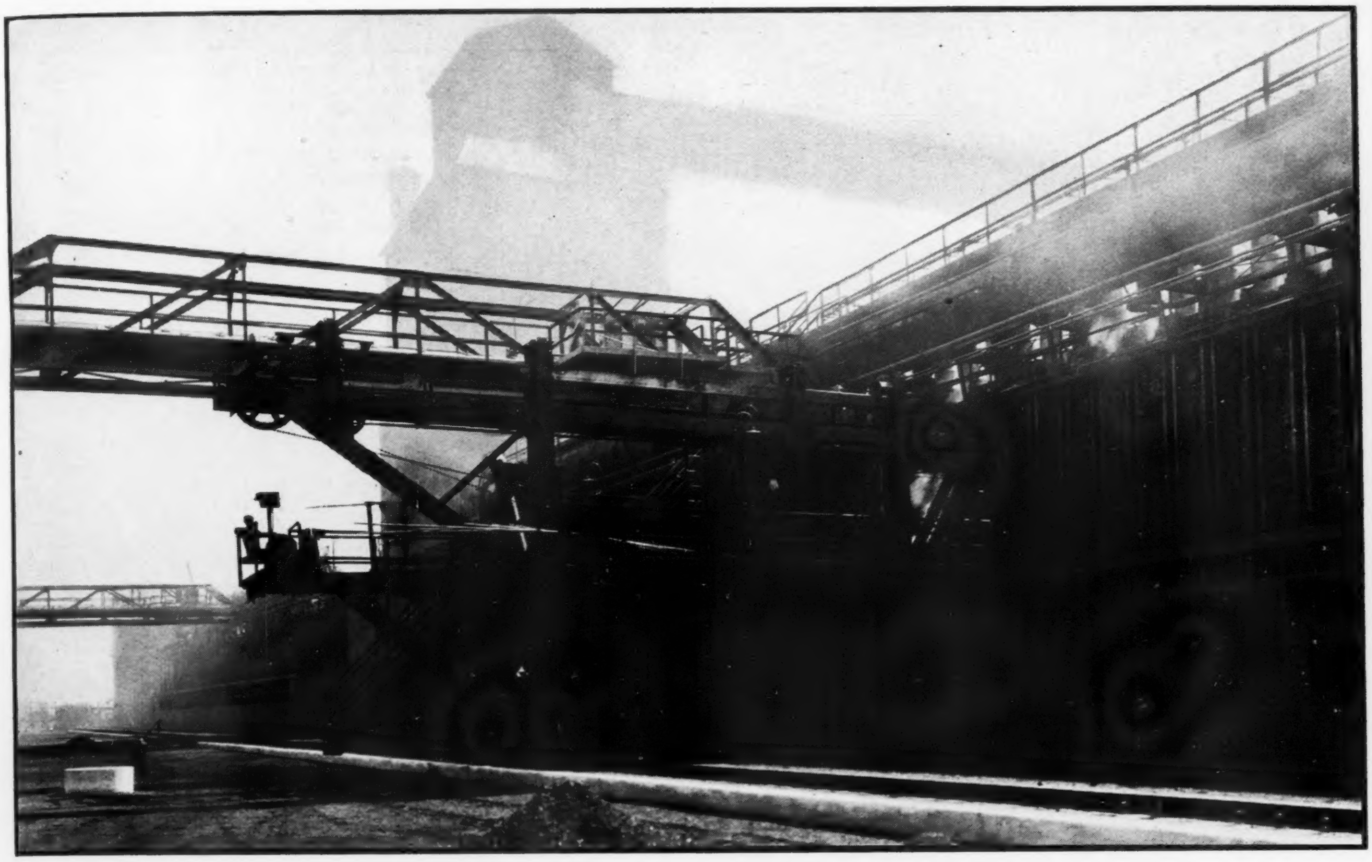
DIVISION STREET AND THE RIVER

The magic of winter transforms a prosaic scene into a thing of beauty. This is one of the numerous gas holders that serve the City of Chicago. The total holder capacity is 124,000,000 cubic feet.



BATTERY OF COKE OVENS

The most effective way to obtain the greatest value from coal is to distill it, thereby producing fuel gas, various tars and oils which serve the arts and industries, and coke. The distillation is carried out in rectangular metallic chambers constructed in multiple units abutting one another. This picture shows a portion of the battery of 105 Koppers coke ovens at the Crawford Avenue plant. The gas thus manufactured forms part of Chicago's supply. The coke is used in this and other plants to make carbureted water gas, which also enters the mixture which is sent through the mains.

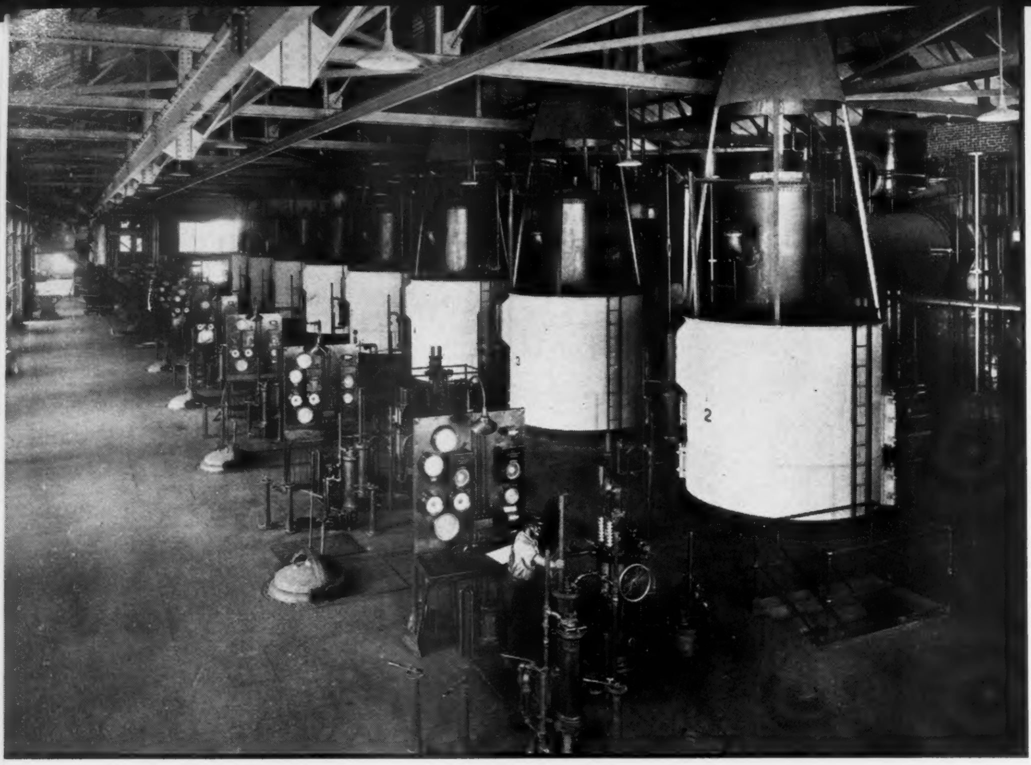
Serving Chicago with Gas

C. H. Vivian

IT OFTEN happens that we know comparatively little about the things that enter into our daily lives. For example, those of us who dwell in cities have grown so accustomed to obtaining water, electricity, and gas merely by flicking switches or turning valves that we seldom give a thought to the means by which those important utilities are brought to us. It is only when something goes wrong that we have occasion to consider the mechanics of the systems of supply, and it is a tribute to those that direct these services that we are rarely given any reason to ponder such matters at all. Yet, all of us are aware that vast and intricate networks of physical equipment are involved. From time to time we see gangs of men digging in the streets and doing something or other to the pipes or conduits. Here and there we notice generating stations, pumping plants, or gas-producing plants, and we know that these are sources of supply. We likewise are conscious that the planning, construction, maintenance, and operation of these systems call for careful thought and scrupulous attention by well-ordered organizations. But most of us have only a cursory and impersonal knowledge of all these things, for in the tangled skein of life we have our own little knots to untie, and we are kept rather busy untying them.

It may be of interest, then, to look behind the scenes of a large gas company: to learn something of its physical structure and of its problems and the manner of meeting them. For the purpose of such an examination we are privileged to use The Peoples Gas Light & Coke Company, of Chicago, Ill., one of the leaders in its field. It supplies gas to the second largest city of the nation, distributing it throughout an area of 214 square miles inhabited by approximately 3,500,000 persons. In addition, it delivers gas to other concerns which, in turn, serve a number of communities contiguous to Chicago. Thus, directly and indirectly, it takes care of the gas requirements of about one-thirtieth of the population of the United States. Its actual customers number approximately 800,000. Something like 70 per cent of the gas it sends out is used in households, the remainder is consumed by industries.

A utility of such proportions is, of course, the result of a process of evolution, which is another way of saying that it has undergone continual change. The relation between a city and its gas service is much the same as that between a small boy and a suit of clothes: in each instance, growth calls for periodical alterations, with occasional new outfittings. When a city shows such vigorous expansion as has Chicago, it proves somewhat difficult to maintain the fit. Moreover, to carry the analogy further, there are changes in style of gas systems just as there are in clothes. Technological developments and improvements in equipment make advisable frequent modifications or replacements for the sake of greater economy or better service. Thus, the re-



WATER-GAS GENERATORS

Operating floor of the Crawford Avenue plant. Here steam is passed through incandescent coke and enriched with "cracked" oil. The same units are used to make reformed gas by substituting natural gas as the enriching agent.

sponsibility of a gas company is not alone to render adequate service today but to anticipate the needs of tomorrow so as to be prepared to meet them.

The history of gas distribution in Chicago is almost a measure of the city's transformation from a sprawling prairie town into a metropolis of the plains. This spectacular change has taken place within the relatively short period of 85 years. During that span the status of gas has changed from something to excite public awe and wonderment to a household and industrial servant that is indispensable. When gas distribution was inaugurated in Chicago, its sole function was illumination. Today its use for that purpose is insignificant, but its field of service has expanded to limits which were beyond the conception of the 1850 mind.

Although the Chinese of fifteen centuries ago are known to have conveyed natural gas through bamboo tubes and employed it for lighting, the first successful public lighting project was that of London, where, in 1807, Pall Mall was illuminated by means of coal gas. America's first gas company was chartered in Baltimore in 1816. Boston had gas service in 1822, and New York a year later. Chicago was then but a hamlet, and Cook County, in which it is situated, had not yet been organized. Once it started to grow, however, Chicago proved to be a veritable municipal mushroom. By 1848 it was approaching the 30,000 mark. Its citizens looked with envy upon Cleveland and Detroit, both of which already had gas companies.

Up to that time Chicago had been handicapped by inadequate means of obtaining coal from which to make gas. Wood was the city's fuel. Such coal as Chicago saw was brought in sailing vessels from the East. Eighty tons of it arrived from Erie in 1841, but it required two years to dispose of it, not only because of its price but also because there were no facilities for burning it. But the situation was changed by the construction of the Illinois and Michigan Canal. This was destined to be opened on April 10, 1849, affording low-cost transportation of coal from LaSalle.

With this momentous event in the offing, a group of Chicago's leading citizens met in the law office of Norman B. Judd, at 41 South Clark Street, on October 16, 1848, and drew up an application to the state legislature for permission to incorporate a company to supply manufactured gas to the city's streets and houses. The outcome of this meeting was the Chicago Gas Light & Coke Company, the first of the numerous gas companies which the city was eventually to have. The charter which gave it life was signed by Gov. Augustus C. French on February 12, 1849. Although no significance was attached to it at the time, this happened to be the fortieth birthday of a gangling downstate lawyer named Abraham Lincoln. Twenty years later, in Chicago, he was nominated for president; and the man who presented his name was the same Mr. Judd who was mentioned a few lines previously.

The charter gave this initial gas concern the power to do business perpetually, fixed its capital stock at $300,000, and granted it the right to hold real estate up to $50,000 in value. In 1849 the company contracted with Chicago for the laying of gas mains, and it was given a monopoly of the city's lighting business for ten years. The price of gas for street illumination was fixed at $2.50 per 1,000 cubic feet, for householders it was $3. With these preliminaries out of the way, construction of a gas plant and distribution system was begun. Seven furnaces for making coal gas were set up, and a 60,000-cubic-foot holder was provided. Twenty-four thousand feet of piping was laid in the streets, including 1,000 feet of 10-inch mains.

On August 28, 1850, one furnace was started up. A week later the holder was full, and word went around that service was to start. The company had 125 private customers and 99 street lamps to supply. Excitement ran high. Nightfall was several hours away, but impatient subscribers, including the city fathers, lighted their lamps regardless. That day, September 4, 1850, marked a milestone in the life of Chicagoans. They felt citified at last. In its next day's issue, the *Evening Journal* commented: "Some of the stores on Lake Street, particularly those devoted to California ware, made a brilliant appearance, and the gas lent an additional glory to refined gold. But the City Hall, with its 36 burners, was the lightest of all, night being transformed into mimic day." The reference to California ware and refined gold was occasioned by the displays the stores were making of articles for outfitting parties participating in the gold rush.

During the next decade the Chicago Gas Light & Coke Company had the field to itself, and it prospered. There was a phenomenal leap in population from 30,000 to 110,000. The company's pipe lines grew in length from five miles to 53 miles, and its customers mounted from 125 to 2,000. It should be borne in mind that all the gas was used for lighting. Not until after 1880 did its service for heating attain any prominence. Naturally, gas light was a big advance for people who had been dependent upon candles and lamps which burned whale oil or camphene (rectified oil of turpentine).

In February, 1859, a charter was granted The Peoples Gas Light & Coke Company, its incorporators having offered to supply 1,000 cubic feet of gas at 50 cents less than the prevailing rate. Trouble was encountered in financing it, however, and it owed its actual start in business three years later to the loosening of purse strings by two newcomers, A. M. Billings, of Vermont, and C. K. Garrison of San Francisco. The launching of this concern signalized that Chicago was open to competition in the matter of gas supply. The companies agreed to divide the territory, and held to the pact for 25 years, by which time the situation had become complicated through the formation of other gas companies. Thereafter, there seems to have been a general scramble for business. In all, thirteen concerns became engaged in the pursuit of furnishing gas to the rapidly growing city, not including such private industries as the George M. Pullman manufacturing plant which was obliged to cease distribution when the courts ruled that its charter did not authorize sales to others.

It is not necessary for us to devote space to the manifold activities of these various

companies, nor even to enumerate them. Our purpose is merely to show that many components entered into the development of the present consolidated system. It need hardly be pointed out that the linking of such a heterogeneous collection of companies, with their different plants and distribution systems, served to complicate the task of unit operation.

Efforts to bring about a consolidation began in 1887, but were held to be illegal. An act permitting unification became a law on June 5, 1897; and in that same year The Peoples Gas Light & Coke Company took over seven of the other companies. Two more were added in 1898, another in 1906, and the two remaining came under its management in 1913. Since then it has been possible to plan the gas supply of Chicago on a more intelligent basis; but the process of merging the physical equipment inherited from so many sources has been a tedious one and is not yet completed. For example, in certain sections such as the Loop District, formerly served by several concerns, there are still as many as six separate mains beneath the streets. As these become unfit for service their use is discontinued, and eventually there will be only one set of pipes.

Chicago is now supplied with three distinct kinds of gas: coal gas, water gas, and natural gas. We have already mentioned that coal gas was first employed. As its name implies, it is obtained from coal which, when subjected to distillation, yields large volumes of gas in addition to tars and oils which form the basis for numerous essential chemicals, dyestuffs, paints, etc. The residue is coke. The composition of coal gas varies, but usually it contains from 30 to 40 per cent of methane, around 50 per cent of hydrogen, and differing quantities of carbon monoxide and other gases.

So-called water gas, which is technically known as blue gas, was introduced about 1880. This is made by passing steam through a bed of incandescent carbon such as coke. It is carbureted or enriched by "cracking" oil in a chamber through which the gas is passing. By varying the quantity of the oil, gas can be produced ranging in heating value from 300 to 700 Btu's per cubic foot. When it is from 525 to 650 Btu's, which is the usual practice, the composition consists of 30 to 40 per cent hydrogen, 28 to 35 per cent carbon monoxide, 10 to 15 per cent methane, and 8 to 12 per cent unsaturated hydrocarbons.

As it takes less labor to manufacture water gas than it does coal gas, apart from the added advantage that there are no troublesome by-products to be handled, the use of coal gas as made in retorts was largely discontinued towards the end of the last century, and virtually all the plants supplying Chicago adopted the water-gas process. This proved satisfactory until the World War period, when the prices of coke and oil rose to such heights that the company, already burdened with increased labor costs, could not make a profit. Appeals for permission to raise rates fell upon deaf ears, and a financial crisis impended. The difficulties were surmounted through an arrangement with the Koppers Company, of Pittsburgh, Pa., under which that concern was to build a modern coal-gas plant and allow The Peoples Gas Light & Coke Company to pay for it out of earnings over a period of years. This plan has been carried through. The plant is located at Crawford Avenue and 35th Street, where 363 acres were acquired and a total of $28,000,000 was expended. It consists of a battery of 105 coke ovens, with complete facilities for treating the gas and its by-products. From these ovens comes the coke which is used there and at other plants in the city for the making of water gas. Surplus coke and by-products are sold.

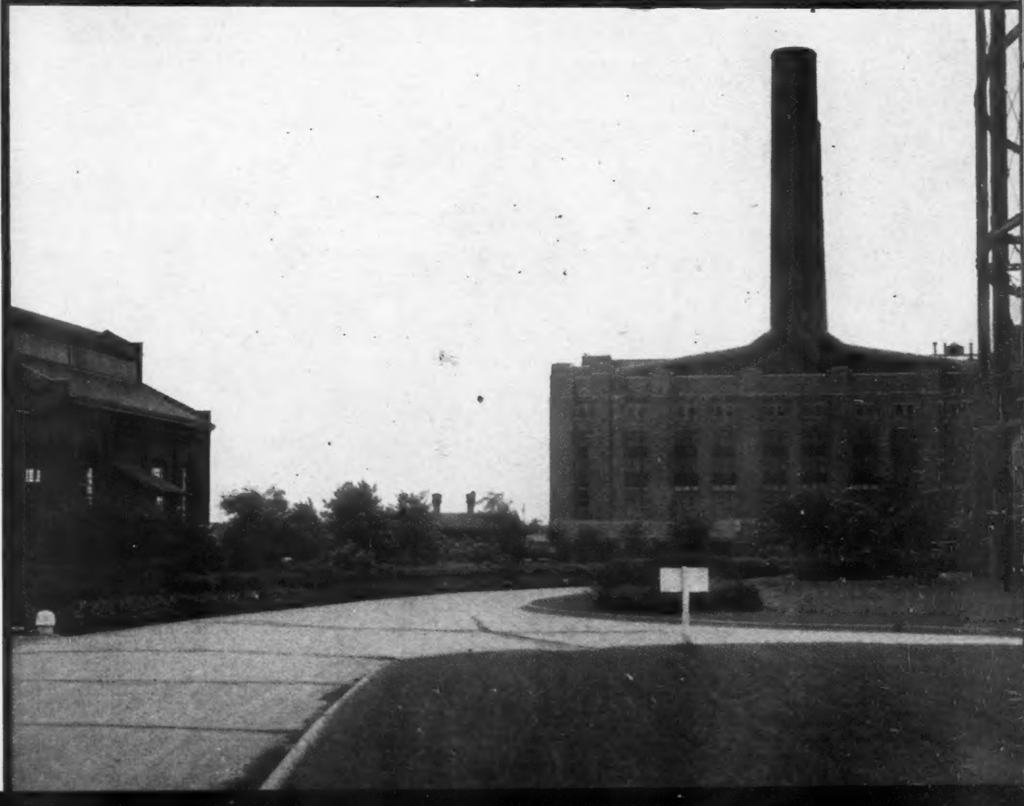
Until 1931, both coal gas and water gas were distributed, the two being mixed into a uniform product having a heating value of 530 Btu's per cubic foot. Then, in 1931, natural gas reached Chicago. The advantages of this fuel were immediately apparent, and, fortunately, there was a way by which it could be utilized without scrapping the existing costly equipment for manufacturing coal gas and water gas. The natural gas has a heating value of 1,035 Btu's per cubic foot, which is higher than is desirable for city service. Accordingly, it was decided to mix it with coal gas and water gas in suitable proportions to reduce its heating value to 800 Btu's, and that is being done.

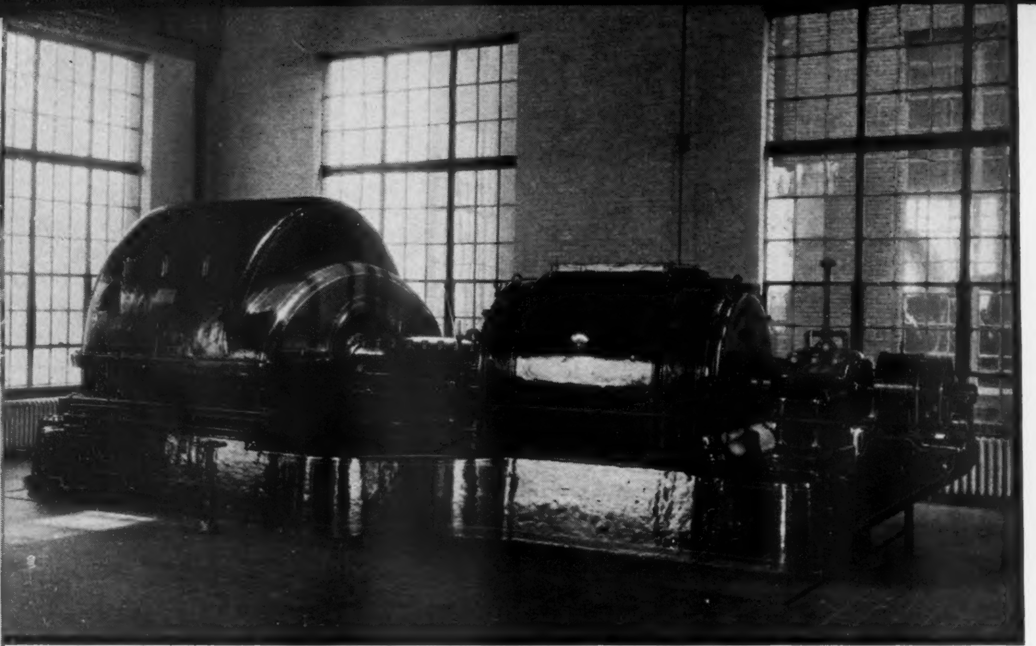
In this connection it is of interest to note that gas is no longer sold in Chicago by the cubic foot but by the therm. A therm is 100,000 Btu's. Under this system customers buy a given quantity of heat rather than a given amount of gas. Thermal rates were originated in Great Britain during the war to equalize charges in the face of reductions in the heating value of gas resulting from the inability of utilities to obtain suitable materials for gas-making and sufficient labor for operating and maintaining plants at normal efficiency. In order to acquaint customers with the new rates in advance of the coming natural gas, the Chicago company introduced the therm basis on August 1, 1930. It was the first American utility to adopt the thermal system, which is now being used by companies serving approximately 10 per cent of the gas customers in the country. It is well to recall here that candlepower was the measurement of the value of gas in the days of gas illumination. The Btu. yardstick was applied when gas heating became important—electricity, meanwhile, having gradually supplanted gas for lighting purposes.

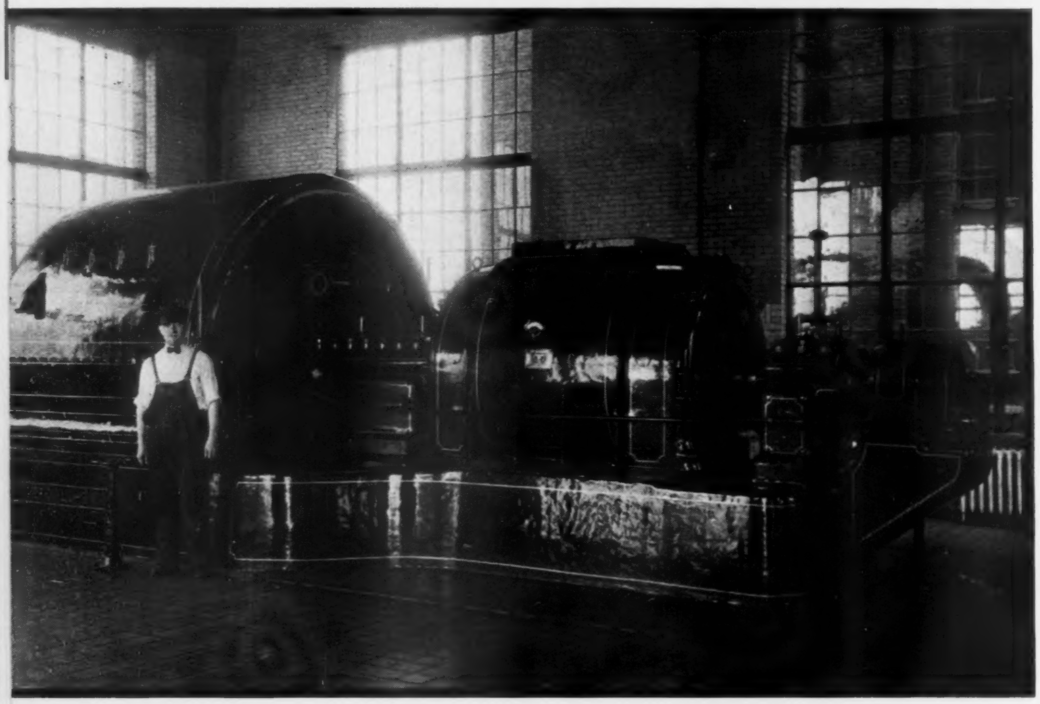
The natural gas that reaches Chicago originates in the Texas Panhandle. A 24-inch pipe line, along which are located ten compressor stations, extends 900 miles from Fritch, Tex., to Joliet, Ill., and is operated by the Natural Gas Pipe Line Company of America. From Joliet to Chicago there are two 24-inch pipe lines, duplicate facilities being provided to lessen the possibility of an interruption in the service because of line failure. The Joliet-Chicago lines are controlled by the Chicago District Pipeline Company which sells gas to The Peoples Gas Light & Coke Company, Public Service Company of Northern Illinois, and Western United Gas & Electric Company.

One line, 48 miles long, comes in at 98th Street, in the extreme southeastern section of the city. The other, which is 36 miles long, runs to the Crawford Avenue plant. At the former location, in what is known as the Calumet area, an entirely new station

LANDSCAPING AT THE CRAWFORD AVENUE PLANT







AN UNUSUAL RECONSTRUCTION FEAT

These pictures show the alterations that were made in two duplicate turbo-blowers at the Crawford Avenue plant to enable them to meet the changed operating conditions which followed the adoption of a medium-pressure loop transmission system. The blower ends of the units were rebuilt in six stages instead of four, and a power wheel was added to each without disturbing the driving motors or base plates. The upper picture illustrates one of the units as it was originally installed, and the lower one shows it as it now is. Close examination of the blower (left) end will reveal that it was considerably enlarged but still made to fit the original base plate and foundation. The cylinder on the end of the casing and right of the man is the control element for the power wheel, a device which permits varying the performance of the machine to meet changing operating conditions economically. In all, The Peoples Gas Light & Coke Company has seven turbo-blowers of this type, all driven by synchronous motors. One of them will handle 72,500 cfm. of gas at a maximum discharge pressure of 6½ pounds, and is reputed to be the largest centrifugal gas-pumping unit ever built.

was built. There has been in existence there for a number of years a pumping plant for sending out coke-oven by-product gas received from steel companies operating a short distance away. The new station is equipped to mix this coke-oven gas with the natural gas and to distribute it, the old plant being retained for standby service.

Chicago is 25 miles long and averages about 8½ miles in width. Its longer dimension runs north and south. Lake Michigan forms the eastern boundary, which is a fairly uniform line, but the western side is irregular. The demand for gas naturally varies widely in different parts of the city. There are several local concentrations of manufacturing establishments that are heavy consumers, but the greatest of them all is the well-known Loop District which is about midway of the north-south limits and on the side towards the lake front.

As the city grew and acquired additional gas companies the natural tendency was to build new gas plants in the younger sections, so that gradually there came to be a number of small systems each serving a limited territory. There was some overlapping of distribution lines; but in general each company had its own field of service. It can be realized that the knitting together of these units into one compact, economical, and reliable system while retaining as much of their physical equipment as possible constituted a problem that took years to work out. This problem has been further complicated by the continued rapid growth of the city and by the operating company's obligation to keep an eye on probable future trends and requirements and to plan for them as well as for current needs. Gradually, however, out of this multiplication of gas plants and this maze of independent distribution lines has emerged an interconnected, city-wide system that functions economically and dependably and that ultimately will closely resemble the sort of system that likely would have resulted if there had been only one concern in the field from the outset.

As has been already made plain, the main centers of gas supply for a number of years have been the Crawford Avenue and the 98th Street stations. From the former, situated in the western section of the city, 48-inch mains were laid both northward and southward to feed the distribution system. From the 98th Street plant a 36-inch main was run northward to the Loop District and roughly parallel to the lake front. As the demand for gas grew, these mains were periodically lengthened until they were eventually joined to form a loop. At present a 32-mile 48-inch line connects the two stations and constitutes the western and southern sides of the loop. The eastern and northern sides consist of a 36-inch line that is 35 miles long. Inspection of an accompanying illustration will show that the greater part of the city lies within this loop.

Extending from side to side of the loop at various intervals are cross-connecting mains which are mostly 16 and 24 inches in size. With the loop these form what is called the transmission system totaling 242 miles of pipe line. Gas is delivered to it at pressures ranging from 3 to 8 pounds per square inch. By means of district regulators, of which there are 110 at scattered points, the gas is reduced in pressure to about ¼ pound and fed into the distribution system which serves the customers. There are 3,485 miles of pipe line in the latter system.

To insure uninterrupted service, gas holders and pumping stations have been placed at several points around the transmission system. When the demand is low, gas is withdrawn from the high-pressure system into the holders for storage. During periods of peak consumption this gas is taken from the holders and pumped back

into the loop. One of these holders, that at 73rd Street and about midway between the two gas plants on the 48-inch section of the loop, is the largest in the world. It has a capacity of 20,000,000 cubic feet. The combined capacity of all the holders is 124,000,000 cubic feet.

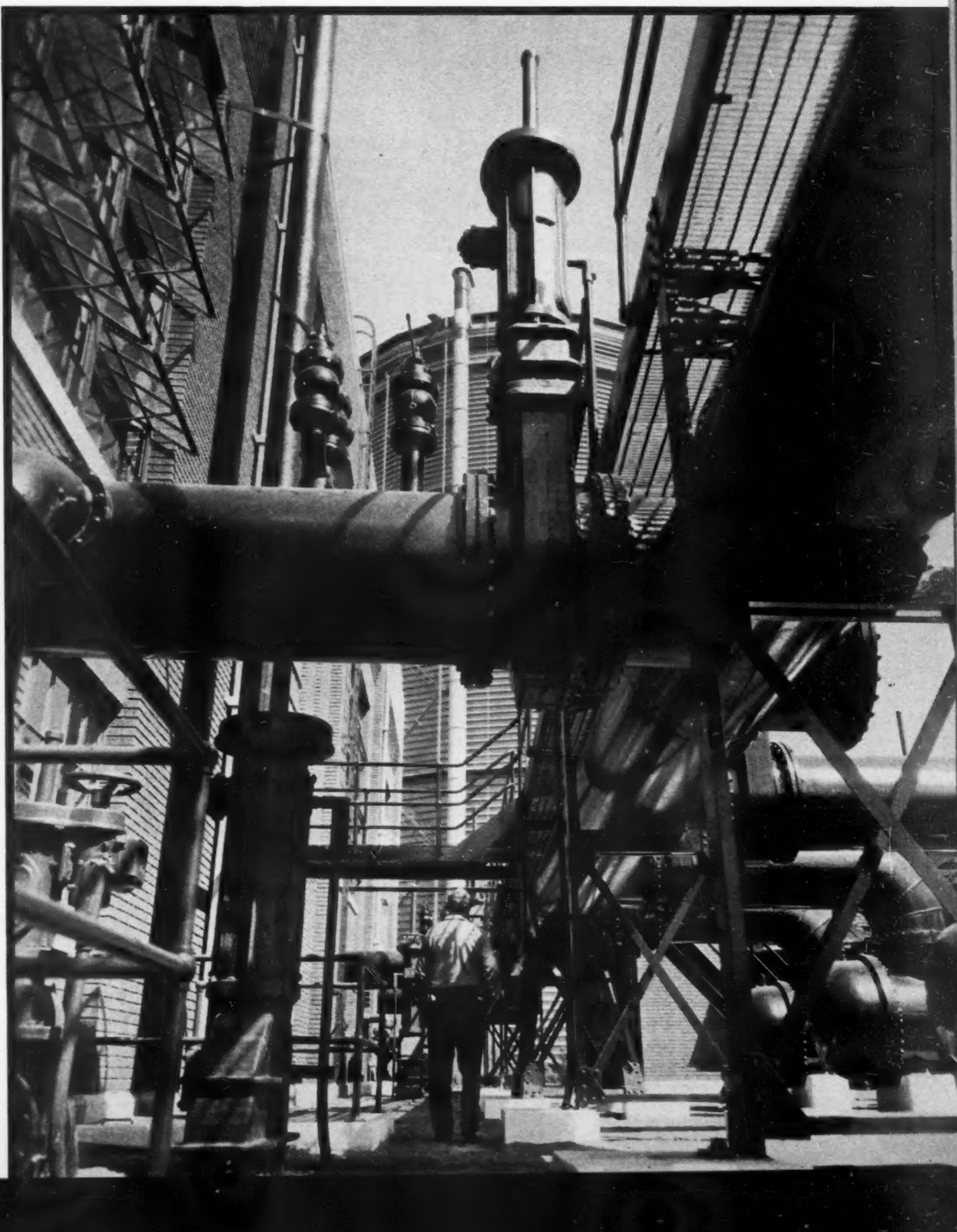
The facilities that have been briefly described take care of the normal requirements. However, in addition to the two regularly used sources of supply there are six other gas stations variously disposed around the transmission system. When occasion demands, any or all of them can be put in service within a very short time. Ordinarily, they are operated only a few days a year, and during a mild winter there may be no need of them. It is of interest here to note that the biggest day's send-out of gas during a year comes on the coldest day of winter because of the heavy requirements for house-heating. The record send-out to general customers in 24 hours was 1,119,804 therms on a January day in 1935. The heaviest send-out for any one hour in a year usually falls on Thanksgiving Day, and is unofficially known as the "turkey load." The record figure in this case is 88,836 therms.

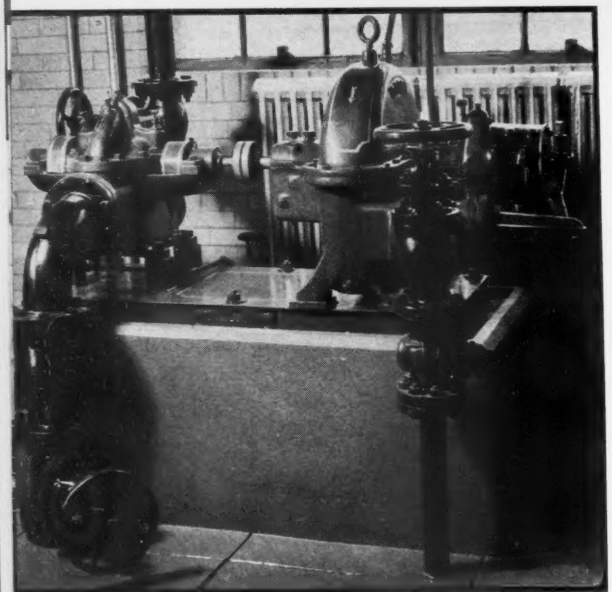
The present system has great flexibility and can meet the city's requirements for many years to come. The maximum pressure employed now is not more than 8 pounds per square inch; but as the load increases in the future the pressure in the 48- and 36-inch loop will be gradually raised and greater quantities of gas accordingly sent out. Ultimately the pressure may reach 20 pounds in this primary transmission section, but it will not be raised above 5 pounds in the other mains. The reduction will be made by means of pound-to-pound regulators at the take-offs.

When it leaves Joliet, the natural gas is under a pressure of 230 pounds per square inch, and at the two stations where it is received in Chicago it varies somewhere between 150 and 100 pounds. At these two points it is further reduced to the send-out pressure. The manufactured gas, on the other hand, must be compressed to the desired point. The equipment provided for this purpose is of two types. At Crawford Avenue there are two large-capacity turboblowers, of which more will be said presently. At the new Calumet station are installed four large reciprocating compressors of which two are of the direct-connected, gas-engine-driven type and the other two, which are held as standbys, are direct driven by synchronous motors. At the other pumping plants, which are operated intermittently or held in reserve, the equipment varies in type. Because of their diverse ages, these units indicate fairly well the changes that have come about in this class of machinery during the past few decades. For example, in the old Calumet station, which is now maintained merely as a standby plant, three distinct classes are represented. The oldest is a displacement booster, which was the pride of the oper-

WHERE GAS IS MIXED

The view above shows a part of the 96th Street station, one of the two points in the city at which natural gas comes in from Joliet, Ill. Manufactured gas is compressed in the building at the left and then mixed with natural gas in the small brick structure at the right to form a uniform product with a heating value of 800 Btu's. The lower picture is an unusual camera study made beneath the 30-inch headers from the compressor building and with a 10,000,000-cubic-foot gas holder in the background.





GAS-COOLING EQUIPMENT

At the Crawford Avenue plant the gas coming from the compressors is cooled by means of the Ingersoll-Rand aftercoolers shown above. One of the centrifugal pumps that supply cooling water for this service (left) is unusual in that the turbine which drives it is actuated by natural gas at 80 pounds pressure. The pump is a Cameron 3UV.

ating personnel when it was placed in service in 1893. In the same room are two displacement boosters of more recent date, and also two Ingersoll-Rand turbo-blowers that were installed in 1925.

The adoption of the loop as a primary medium-pressure feeder line in the distribution system naturally brought about changed operating conditions for the gas-pumping equipment. We have already pointed out that the pressure in this loop goes as high as 8 pounds per square inch during peak loads and that gradually increasing pressures are contemplated as the company's business expands. Before this loop was in existence all gas was sent out at lower pressures, and the machines that handled it were designed accordingly. Included among these were the two turbo-blowers at the Crawford Avenue plant which were mentioned in the preceding paragraph. These units were built by the Ingersoll-Rand Company and were installed in 1925 and in 1927, respectively. They were 4-stage machines. Each was driven at 1,800 rpm. by a 2,700-hp. synchronous motor and had a rated capacity of 3,600,000 cubic feet per hour at a maximum discharge pressure of 6½ pounds per square inch.

As they stood, these blowers were not adapted to the new operating conditions. When there was a small demand for gas, which could be satisfied with low send-out pressures, their capacity was too large. It would have been possible to meet this need by throttling, but that would have meant a large and costly waste of energy. When the demand was great, the pressure required to push large volumes of gas through the system was beyond their limits. As the purchase price of the two units ran into six figures, and as they were in excellent shape, the company was naturally loathe to scrap them.

The problem thus presented was submitted to Ingersoll-Rand Company, with the gratifying result that the blowers have been rebuilt to satisfy the operating conditions. The remarkable part of this accomplishment is that the changes were made without disturbing the base plates of the machines. New and larger shafts, impellers, and casings were made and placed in position within the existing space limits.

To increase their discharge pressures it was necessary to rebuild the units in six stages instead of four; and to obtain the operating flexibility desired there also had to be included within each casing a power wheel that had not been there before. Fortunately, the driving motors had 4,000-hp. windings and frames and could develop the greater power required without the need of making any alterations. The operating speed remained unchanged at 1,800 rpm.

The power wheel is a patented mechanism which puts to beneficial use the energy ordinarily lost in throttling. The effect of throttling is to convert pressure energy into velocity energy. Usually, this is dissipated by turbulence and internal friction. The power wheel recovers a large portion of the velocity energy by causing it to do mechanical work. This is accomplished by throttling through a system of movable guide vanes disposed around a radial reaction-type turbine wheel. The vanes serve to direct the streams of high-velocity gas upon the blading of the power wheel. The torque or turning force thus induced is transmitted right to the blower shaft, and the driving motor is consequently relieved of that amount of power.

The addition of a power wheel has made it possible for these units to satisfy a wide range of operating conditions. Knowing that future requirements would probably vary from time to time, the company enumerated certain conditions that might have to be met, and the redesigning was done accordingly. The specifications not only called for the handling of different volumes of gas at different discharge pressures but also took account of changes in the specific gravity of the gas that might come about through variations in the proportions of the components which now enter into the mixture or through the introduction of new kinds of gas that are not used at present. We can best illustrate the flexibility of the blowers by restating the actual and hypothetical operating conditions for which they were designed.

When running unthrottled each blower will deliver 2,100,000 cubic feet of gas per hour under the following conditions:

Gauge Pressure Lbs.	Sp. Gr.	Bhp.
12.2	0.40	2,160
16.2	0.50	2,710
17.4	0.53	2,870
19.1	0.57	3,080

Maximum volumes obtainable within the available 4,000 hp. under varying conditions are:

Cubic Feet Per Hour	Gauge Pressure	Sp. Gr.
3,960,000	9.6	0.40
3,300,000	15.0	0.505
3,330,000	14.7	0.50

It will take 3,800 hp. to meet the first of the foregoing requirements, and the full 4,000 hp. for the second and the third. In each instance the performance is based upon the handling of gas at 60°F. intake temperature, 3 inches of water pressure, and with a barometer reading of 14.4. With gas of 0.5 specific gravity, with the intake conditions the same as those just mentioned, and with various degrees of throttling, each unit will deliver 900,000 cubic feet per hour at 7 pounds discharge pressure and will use 1,200 hp. At 10 pounds discharge pressure, each will deliver 2,100,000 cubic feet per hour and will use 2,160 hp. At 12 pounds discharge pressure, each will deliver 2,700,000 cubic feet per hour and will use 2,845 hp.

Mention has been made of mixing the natural gas directly with the manufactured variety. This procedure is not followed,

however, with respect to all the natural gas. Instead, some of it is first treated to make what is known as reformed gas. This is done by substituting natural gas for oil in enriching water or blue gas. The advantage herein lies in the fact that such reformed gas, when having a heating value of 530 Btu's, can be varied in chemical components and in specific gravity from those of coal gas to those of ordinary blue gas. Thus, by reforming a portion of the natural gas, the problem of properly mixing the several components of the final product is simplified. The actual mixing is done mechanically by means of Smoot controls. By this process there is created a turbulence which diffuses the different kinds of gas thoroughly—the desired Btu's being automatically maintained at all times through the admission of the correct proportions of rich and lean gas.

In 1934 the total send-out of the company, exclusive of the interruptible-supply sales, was 285,504,101 therms of gas, or the equivalent of 35,650,000,000 cubic feet. Of this, 229,662,372 therms were for customers served by the firm's own distribution system, while 55,841,729 therms were for other utilities. As The Peoples Gas Light & Coke Company contracts to take a given amount of natural gas each day, it is evident that fluctuations in the demand will occasionally make it impossible to utilize it all. The surplus is therefore sold to industrial consumers on an interruptible-supply basis.

As all burners and appliances are adjusted for 800-Btu. gas, and would function improperly if it suddently became necessary to send out an all-manufactured gas of lower heating value, the question arises as to what would happen in case the natural-gas supply failed. Needless to say, provision has been made to meet such an eventuality. We have already mentioned the precaution that has been taken by running a double delivery line from Joliet. As an added insurance, 300,000 gallons of butane are held under pressure in underground storage tanks at the Calumet plant and 200,000 gallons at Crawford Avenue. If that pressure were released, an enormous volume of gas with a heating value of 3,200 Btu's per cubic foot would become available. This could be used in an emergency to enrich the manufactured gas to the desired 800-Btu. rating until such a time as the natural-gas supply could be restored.

One of the most interesting and most important phases of the operating system is found in a rather small room in the main offices of The Peoples Gas Building in downtown Chicago. On a wall is a large map of the city showing the locations of the transmission lines, gas holders, and pumping plants. At a desk sits a man whose duties are akin to those of a railroad dispatcher. It is his function so to direct the send-out that the needs of customers will be met and that all storage holders around the network will be filled by night so that a reserve supply of gas will be available.

The volume of gas used depends largely upon weather conditions, so the forecaster's reports are scanned with great care. After a day is well underway, the probable gas consumption during the hours to come is estimated by a comparative method. Let us assume that it is ten o'clock in the morning. With the temperature record of the past several hours in front of him, the man at the desk selects from his voluminous files a card showing the hourly gas send-out on a recent day that started out with about the same temperature range as that which has prevailed thus far that morning. The card shows the gas demand that may reasonably be expected during the ensuing hours. Regular reports on the rate of send-out from each plant and on the amount of gas in the various holders arrive regularly at this office, and careful periodical analyses of these data, together with the indications of coming weather, form the basis for the instructions which go forth to pumping-plant operators at intervals. Any sudden change in weather of course causes a reconsideration of the expectancy of gas consumption for the remainder of the day.

THE DISPATCHER'S OFFICE

From this room in downtown Chicago the functioning of the entire system is controlled. The map shows the gas plants, mixing stations, holders, and transmission mains. By continually watching the weather conditions and forecasts, the man at the telephone is able to regulate the production and send-out so as to meet the city's needs and to end the day with all storage holders filled with gas. The principal distributing stations are located at the lower left-hand corner and about midway of the heavy line that crosses the upper part of the map. The city is surrounded by a loop of 36-inch and 48-inch mains, and these are cross connected at various intervals by smaller mains. From these, by means of district pressure regulators, the gas is fed into the distribution network which serves customers.

AIR CONDITIONED

The New York Trust Company building, in New York City, in which a steam-jet water-vapor refrigeration unit is installed for air conditioning.

Water-Vapor Refrigeration for Air Conditioning

Fred H. Hibbend

IT NOW appears certain that air conditioning will be one of America's new industrial giants. Already, according to one authority, it is saving $15,000,000 annually for manufacturing concerns. As air conditioning has been applied to only a small percentage of the lines of industry that can profitably use it, and as the conditioning of homes, business buildings, hospitals, and kindred structures is still in its infancy, the enormity of the potential field of application awaiting this new development in refrigeration is readily apparent.

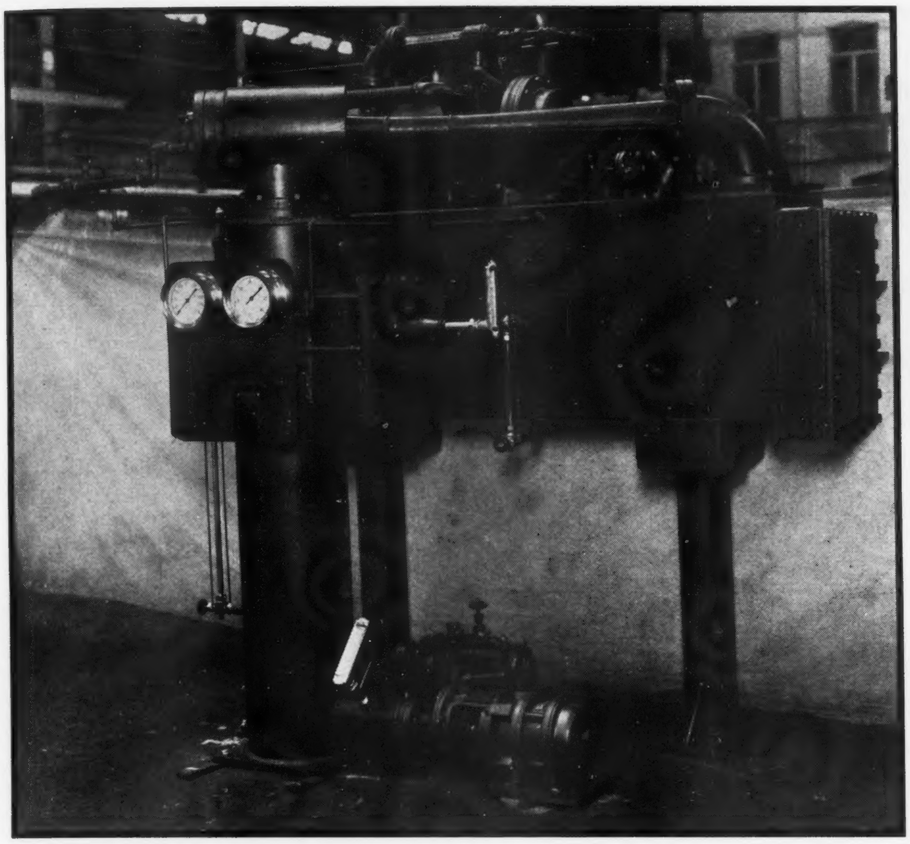
So far air conditioning has been adopted by more than 200 industries. That is to say, that number of individual departments of industrial endeavor has found that control of temperature and humidity facilitates production processes sufficiently to make it pay its way. In some cases this modification of normal indoor weather is indispensable. The most familiar example is that of textile plants which, by artificially reproducing the atmospheric conditions of New England, were enabled to break with tradition and to establish themselves in the cotton-growing sections of the South.

The list of the products now manufactured in conditioned air includes materials of diversified natures ranging from chewing gum to sausage, from the making of terra cotta to the printing of magazines. In some cases the setting up of suitable conditions involves only adding to or subtracting from the normal moisture content of the air. In other instances it involves complete air conditioning, which means control of temperature, humidity, cleanliness, and air movement. As examples of these several classes are familiar to all, it is not our intention to deal with them but only to emphasize the point that apparatus is now obtainable which will manufacture the exact brand of indoor weather that may be desired.

Motion-picture houses present the best-known example of air conditioning with which the average person comes in contact. Although installations were made as long ago as 1919, the first large movie theater was thus equipped in 1924 in New York City. It was rewarded with increased patronage, which paid for the cost of the plant during the initial summer. Nowadays even comparatively small towns have cinemas that are cooled during hot weather. Air conditioning of places where people congregate is, then, no longer a novelty. Some of the installations that are now being made or that have been projected are of remarkable size. Two million dollars has been expended on this one item in the buildings so far constructed in Rockefeller Center, New York City. In the new R. C. A. Building alone the quantity of heat which is removed every 24 hours to insure summertime comfort would heat 400 average-sized homes during a similar period in winter. Approximately 400,000 cubic feet of conditioned air is circulated through the structure every minute.

Air conditioning usually requires refrigeration, and for many years the latter was mostly accomplished by means of natural ice. Incidentally, it is of interest to note here that according to Dr. Berthold Laufer, orientalist at the Field Museum, Chicago, Ill., the Chinese who lived in the Ming period 500 years ago practiced a crude form of house cooling by placing quantities of ice in a brazier which was suspended in the room to be cooled. If this be true, air conditioning is not the modern creation which we generally consider it.

Mechanical refrigeration has been in service for a number of years—ammonia and carbon dioxide being the most frequently employed refrigerants. Of late, many new refrigerants have been introduced, not the least interesting of which is water itself. The possibility of using water as a refrigerant has in fact been known for a



A SMALL UNIT

A 10-ton machine suitable for conditioning a moderate-sized restaurant, store, or similar establishment. The evaporator is at the left, with the steam-jet booster compressor mounted upon it and connected to a surface-type condenser. The pumps which withdraw chilled water from the evaporator and condensate from the condenser are located on the floor. This unit was photographed in the shop prior to shipment.

great many years. Dr. William Cullen applied it successfully in 1755, long before ammonia had been tried. Absorption systems depending upon the evaporation of water to make ice were common years ago; and early in 1900 Sir Charles Parsons was granted a patent on steam-jet refrigeration.

However, the characteristics of water make it best suited for moderate-temperature refrigeration; and within the fairly recent past major development along this line has been undertaken in response to the increased application of air conditioning. As an instance of the acceptance of water-vapor refrigeration, it may be mentioned now that one manufacturing concern, the Ingersoll-Rand Company, is building two steam-jet refrigerating units of 1,200 tons total capacity that are to be used for air conditioning a large auditorium.

In general, two types of equipment have been devised: for steam-jet, water-vapor refrigeration and for centrifugal water-vapor refrigeration. The former is manufactured by several concerns, and we shall consider it first.

The cooling of water in a steam-jet refrigerating system is accomplished by admitting the water to be chilled to a chamber in which is maintained a very high vacuum. A small portion of the water admitted immediately "flashes" or evaporates into steam and, in so doing, absorbs heat from, and therefore cools, the remaining body of water, which then passes on to be removed and re-used. The vapor produced is entrained in a high-velocity jet of steam that forces it through a Venturilike tube or "booster compressor" to a second or condensing chamber in which the vacuum maintained is lower than that in the first so that the available supply of condensing water, at say 70° or 80°F., will serve to condense both the entrained vapors and the operating steam. It is apparent that the cycle is the ordinary compression refrigerating cycle. Water is the refrigerant, and steam instead of a mechanical compressor is used to accomplish compression. The absolute pressures, or vacuums, which must be maintained in the evaporator and the condenser can be determined by consulting any standard steam-table reference. One of the accompanying illustrations shows diagrammatically the operation of such a system.

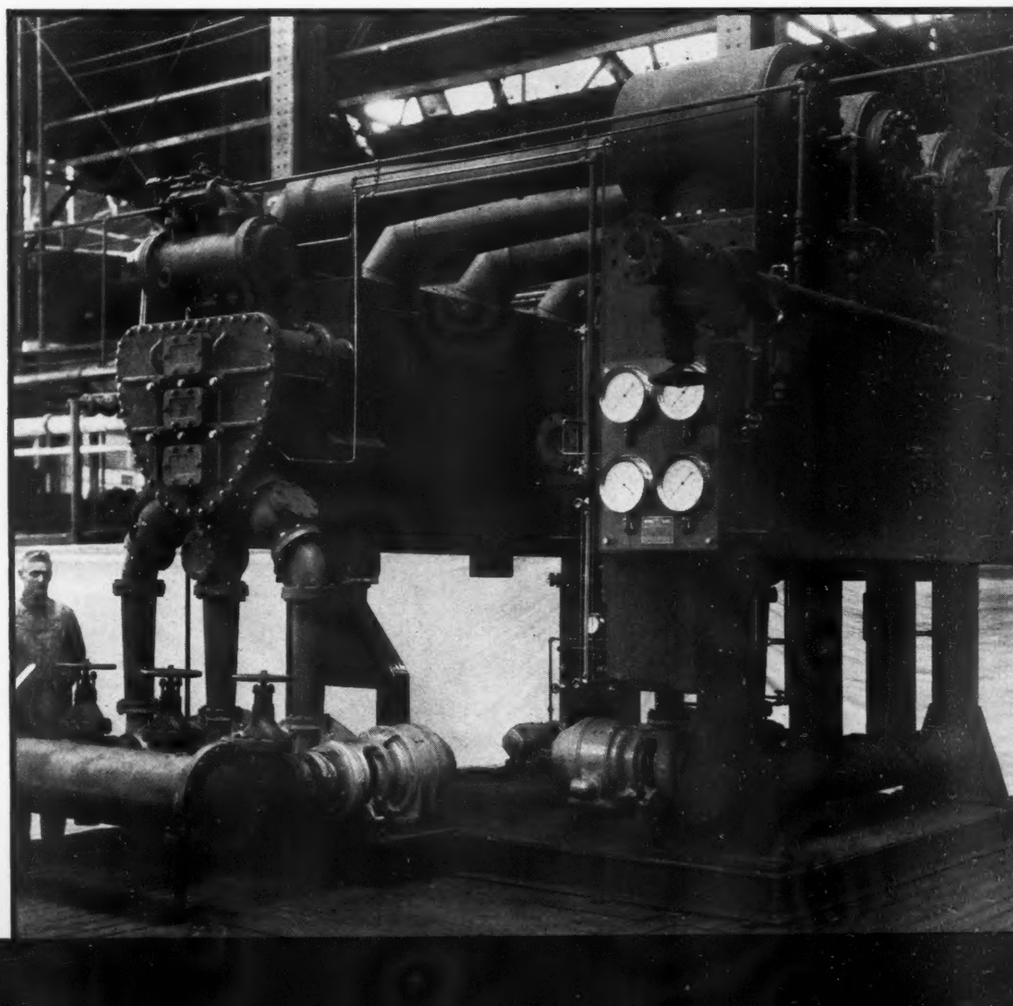
The characteristics, advantageous and disadvantageous, inherent to this method of cooling are clear cut. Its range of application is being established at the present time as these characteristics are weighed in contrast with those of other refrigerating systems. Steam-jet refrigeration has the following potential advantages:

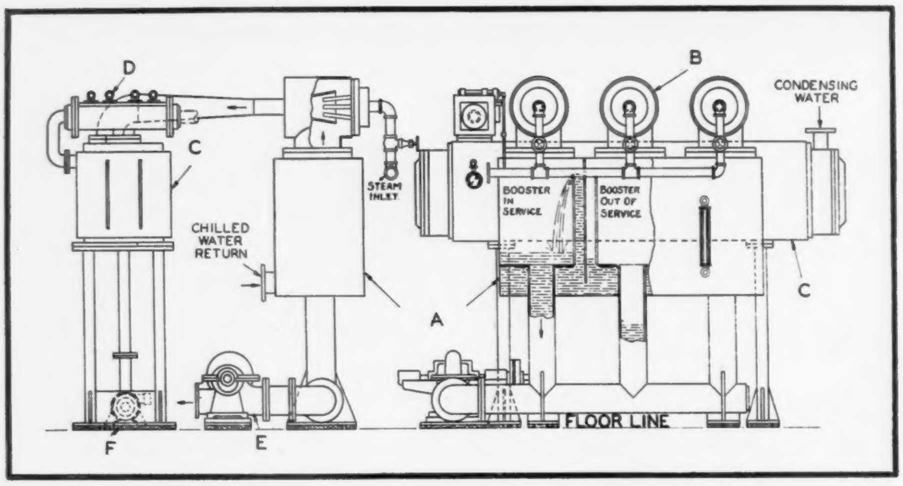
1—Low first cost.

2—Low operating cost.

200-TON UNIT

As shown here, large-size units are built with multiple steam-jet boosters to provide the flexibility required to meet variations in load. Each booster operates with its own associate compartment of the evaporator, and can be placed in or out of service simply by opening or closing the steam-supply valve.





OPERATION OF STEAM-JET UNIT

Water to be chilled is circulated through the evaporator, A, where heat is removed by partial evaporation at a high vacuum. This vacuum is maintained by a booster ejector or ejectors, B, which discharge into a surface or barometric condenser, C, at a lower vacuum. The condenser vacuum is determined by the temperature and quantity of the condensing water employed. Air or other noncondensable vapor is removed from the condenser by means of a 2-stage air-ejector unit, D. Centrifugal pumps E and F handle the chilled water and condensate, respectively.

3—Simplicity of operation.
4—Simplicity of installation.
5—Freedom from vibration and noise.
6—Safety.
7—Reserve capacity.

As against these advantages may be set its disadvantages, namely:

1—Applicable only where live steam is available.
2—Requires more cooling water, or cooling-tower capacity, than do other systems.

It will be worth while to consider individually the characteristics just listed. The first cost of steam-jet refrigerating equipment is usually considerably less than that of equivalent mechanically driven machinery. However, this advantage obtains only where installed boiler capacity or steam from an outside source is available; and the application of jet refrigeration is therefore subject to this limitation. The operating cost of jet refrigeration is frequently lower than that of equivalent electrically driven machinery. This depends, of course, upon the relative values placed upon steam, electricity, and cooling water in the case of the installation under consideration.

With the exception of pumps, which are necessary to any system, steam-jet refrigeration is devoid of moving parts. This means lower maintenance expense, less operating supervision, and less likelihood of failure and forced shutdown. Freedom from vibration and noise is an added advantage. Equipment of this type can be set up in old buildings where foundations for heavy machinery are not available. For the same reasons, steam-jet equipment can be installed other than in the basement, in fact, can be placed anywhere that convenience dictates provided there is sufficient floor structure to carry the dead weight of the apparatus.

Since air conditioning first called for the application of refrigerating equipment, there has been much discussion among engineers and operators as to the hazards incident to the use of various refrigerants. At the present time a great deal is being written concerning the restrictions which municipal and state codes should impose on the refrigerants currently required by or proposed for air-conditioning installations. Steam-jet refrigeration, at least, is entirely safe. It cannot under any circumstances subject the occupants of the conditioned space to the harmful effects of such a gas.

The use of water as a refrigerant for air-conditioning purposes is attributable partly to the fact that the very characteristics which make it unsuitable for low-temperature work adapt it especially for this new field of service. The tonnage capacity of a given steam-jet refrigerating installation is very sensitive to change within the temperature range in which refrigeration must be produced. For example, a unit designed to chill 100 gpm. from 45°F. to 40°F. is capable of chilling approximately 120 gpm. from 50°F. to 45°F. This means that the cooling capacity of the plant can be increased 20 per cent if the chilled-water temperature is raised only 5°, which is relatively a far greater increase than other types of refrigerating equipment can show under the same conditions. A steam-jet refrigerating unit therefore has reserve capacity. This is particularly valuable in air-conditioning when the equipment cannot be installed to meet the worst possible atmospheric conditions—the steam-jet unit being able to take care of the overload without undue changes in temperature.

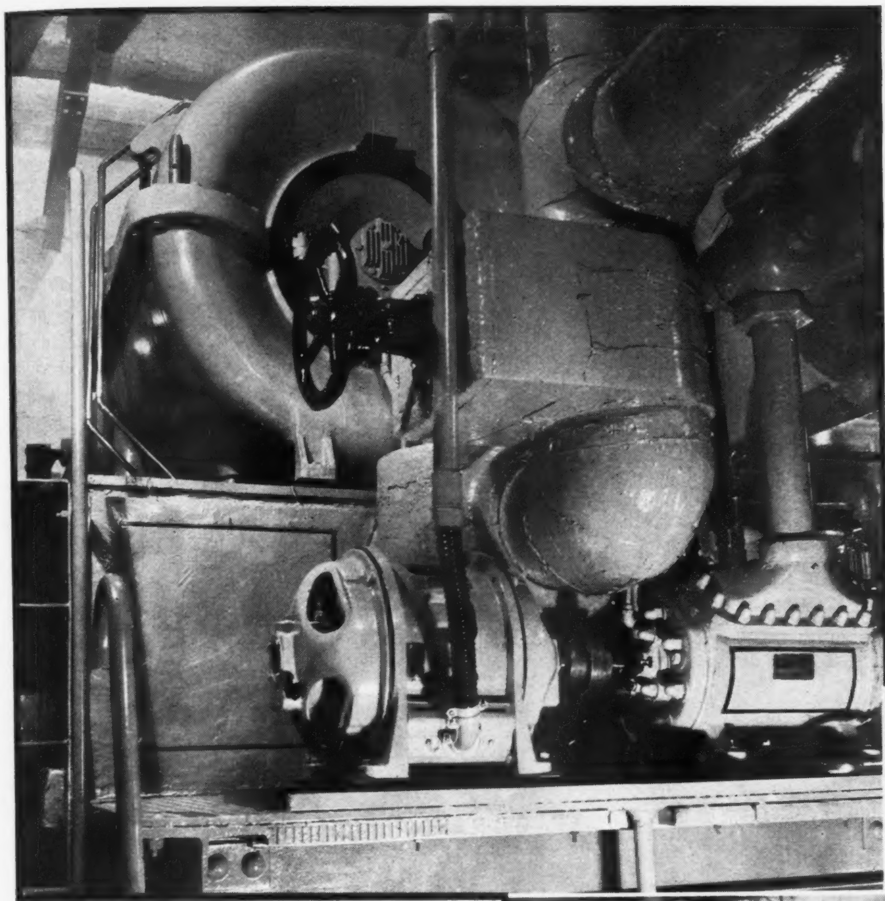
It has been pointed out that steam-jet refrigerating equipment calls for more cooling-water capacity than do other systems. The orthodox type of compression refrigerating equipment requires from 1 to 1.5 hp. per ton of refrigeration. This means that for every ton of refrigeration the cooling water must remove 12,000 Btu's per hour, plus 2,500 to 3,800 Btu's per hour representing heat put in by the compressor. The total heat to be removed by the cooling water per ton of refrigeration is consequently about 15,000 Btu's per hour. The situation is somewhat different with steam-jet refrigeration.

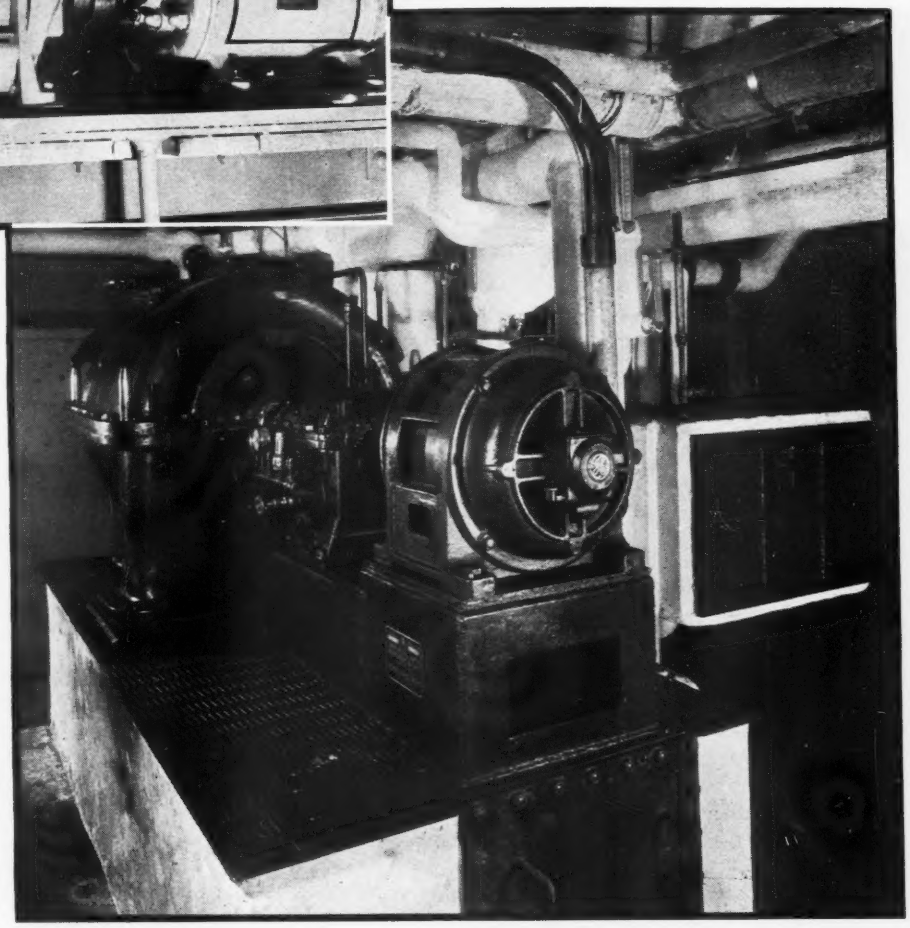
For the average steam-jet refrigerating job approximately 30 pounds of live steam will be needed per hour per ton of refrigerating effect. This steam must be condensed, and the heat removed by the cooling water. The heat to be taken from 1 pound of live steam amounts to about 1,120 Btu's. Therefore the cooling water must remove 12,000 plus 1,120 times 30, or a total of 45,600 Btu's per hour per ton of refrigeration, as compared with the aforementioned 15,000 for other systems.

From the foregoing figures it would seem that steam-jet refrigeration calls for about three times as much cooling water. In practice this is not the case. It is usually possible for steam-jet equipment to be designed for a greater heating of the cooling water so that the quantity required for that purpose is seldom more than twice that needed by the other systems. For installations necessitating cooling towers, this difference is further reduced by carefully proportioning the water quantity, temperature, and tower size. However, it will be apparent that steam-jet refrigeration, as compared with other types, involves either additional operating expense for cooling water from the mains or additional first cost for cooling-tower equipment.

Low-pressure steam down to substantially atmospheric pressure may be used for steam-jet refrigeration, but the steam and condenser-water consumption may be as much as double that when high-pressure steam is utilized. Furthermore, as the water consumption is already relatively high, it is frequently difficult to justify such an installation even where steam is comparatively cheap. The size and cost of the equipment also are relatively much greater in the case of low-pressure steam.

Single-booster units are ordinarily supplied with an "on-off" thermostatic control that is arranged to turn them completely on or off to maintain the desired outgoing-chilled-water temperature. Units of larger size are usually built with multiple boosters to meet variations in load. In one case a unique evaporator of the compartment type is employed. Each booster operates with its associate compartment, and is placed in or out of service simply by opening or closing the steam-supply valve. The slight change in pressure in a compartment between the "off" and "on" condition depresses the incoming water below a specially designed weir and automatically shuts off the supply to the inactive compartment. This eliminates the necessity of manipulating control valves, as is generally required.





TWO CENTRIFUGAL MACHINES

At the left is a centrifugal water-vapor refrigerating unit installed on the 58th floor of a New York skyscraper. It is mounted on special supports carried directly by the steelwork of the building. It is surrounded by offices and is right over a telephone switchboard. Below is shown a unit which supplies chilled water for air conditioning a factory. The compressor, motor, and gear are mounted upon the evaporative water cooler, which serves as a base. The condenser may be seen at the right.

It is very important to note that changes in the capacity of a given unit cannot be made by varying the steam flow through the booster. The effect of such a variation is to leave the capacity practically unaffected but to change materially the back pressure (condenser vacuum) against which the booster operates. Thus a change in steam flow can be made at substantially constant capacity to compensate for changes in condenser-water temperature or rate of flow.

The use of small low-pressure units of this type in conjunction with domestic or other heating boilers is always a question of interest, and surprise is sometimes expressed that more progress has not been made along this line. Steam-jet refrigerating units of small sizes and for operation with low-pressure steam can be built with complete success. However, such units must be standardized and produced in relatively large quantities before there is any possibility of their equaling in cost the standardized small compressor units. So far the available market has not seemed to justify such a course, but there is reason to believe that this will not continue to be the case.

The development of centrifugal water-vapor refrigeration has been relatively far more rapid than that of steam-jet refrigeration, and the resultant commercial product is undoubtedly capable of more general application. Its operation is akin to that of the steam-jet unit except that a mechanically driven compressor of the centrifugal type replaces the steam-jet booster. It possesses similar advantages in that there is no chemical refrigerant to waste away or to cause damage; and, being of the centrifugal type, it eliminates wear or loss in capacity.

On the other hand, the centrifugal type is dissimilar in that it may be driven by the conventional form of constant-speed motor and, under that condition, automatically compensates for part-load output with reduced power input. Furthermore, the power and condenser-water requirements are, in general, comparable with those of the best of the conventional compressor units. Detailed discussion of this type of equipment will be left for a subsequent issue. Meanwhile, some of the accompanying illustrations will convey an idea of its construction.

CANADA'S LARGEST GOLD MINE

The famous Lake Shore property which had produced nearly $74,000,000 up to the first of this year. Contrary to the general rule, its discoverer, Harry Oakes, has retained control of it through numerous vicissitudes and, together with some of the men who were with him before Kirkland Lake came into its own, is still active in its management. Approximately 2,300 tons of ore pass through the Lake Shore mill every day.

Thirty Years of Canadian Mining

Kirkland Lake—Part 1

R. C. Rowe

I

Which Relates Its Discovery

"Twas in the grey of an early dawn,
When first the lake we spied."
—F. G. Scott.

IN THE foregoing chapters we have traced in a broad way the northward march from Cobalt which finally ended in the discovery of Porcupine in 1909. Like many developments that are largely the result of chance, the sequence of discoveries in northern Ontario is distinguished by some vagaries that are rather puzzling. The finding of gold at Porcupine before Kirkland Lake is one of these. In the first place, Kirkland Lake lies more than half way between Cobalt, where the march started, and Porcupine, where it culminated. Under ordinary circumstances one would expect that the movement of prospectors northward would have enveloped Kirkland Lake in its progress, and the remarkable fact that it did not is emphasized by the further fact that gold was discovered at Swastika as early as 1905, and Kirkland Lake is only about five miles northeast of that point. We have also noted that gold was found at Larder Lake in the same year, and that there was a rush into that district in 1906. And Larder Lake lies almost due east of Swastika.

As we look back today it seems almost incredible that the strip of country between those two discoveries, which created quite a stir, was not overrun with prospectors. However, the simple fact stands that it was not. It is true that subsequent to the discovery of the Lucky Cross Mine at Swastika a good deal of staking was done to the east of it, and some prospectors must have wandered as far as Kirkland Lake. There is every reason to believe that others penetrated westward from Larder Lake; but no one uncovered gold, and therefore nothing materialized—most of the claims staked reverting to the Crown.

As we gaze back upon these matters we are likely to glean an impression of hiatus. Events were breaking a little too rapidly for anything like organized movement. The stopping places of men, the portages, the trails, in fact the very air, all were alive with rumors which deflected the pioneers from their planned courses. Prospectors turned from Larder Lake to the lure of Gowganda, and from Gowganda they took other trails, probably going back to their starting places on the heels of another crop of rumors. There was a great deal of what appears today as aimless wandering; but it must be remembered that the true prospector is very mobile and very susceptible to rumors.

As we contemplate these things we must also bear in mind that most of the country was unknown at that time, and that the structural features which we have come to know as being favorable to the occurrence of gold were not then catalogued. The men of that day were just starting to scratch the great Pre-Cambrian Shield about which we still have even now a great deal to

learn. They were groping in the dark: they were seeking; but many did not really know what they were seeking, nor where to look. It is a wonder they did so well, and it is doubtful whether we, with all the aids that science and knowledge can give us and with all the experience gained in the crowded years between those days of fast-moving events and the present, could do any better.

But under such conditions it was inevitable that there should be heart-breaking incidents, and fortunes missed by a hairbreadth. We have seen how one man dug a pit on the ground where the Hollinger was discovered three years later; and we have been told that men staked in the vicinity of Kirkland Lake six years before gold was actually found on the "break" that has since become world famous. These things were unavoidable in the excitement; and the eddying movements of men, governed largely by rumor, chance, and the pioneer urge, were bound to result in discoveries that today seem to defy the laws of sequence.

Thus, six years after the finding of Cobalt, Porcupine blazed forth like a beacon amid a welter of unorganized movement. As the spectacular picture of it was unfolded, it crystallized the urge of the seekers. It must be remembered that until then Cobalt and its silver had been predominant in the minds of the men who were spreading over northern Ontario; but the discovery of Porcupine overshadowed that camp and gave a new viewpoint. Gold, which had been located here and there, suddenly became a definite and concrete reality. Almost overnight the white metal lost its lure and gave way to the yellow gold which has warmed and hardened the hearts of men through all the ages.

The success of Porcupine, and the fact that the Lucky Cross Mine at Swastika was obtaining some rather remarkable results, set men to thinking about the burst of activity in the latter district a few years before. Among these were several who were destined to become famous. There was Harry Oakes, W. H. Wright, the Tough brothers, Cliff Burnside, McKane, and others. At this date it is difficult to determine just exactly what it was that took them into Kirkland Lake; and the order of their venturing into the area is not known. However, they were all fairly close together because staking seems to have been carried out very quickly once it started.

The first discovery was made by Wright on the shores of Kirkland Lake late in 1911, less than two years after the finding of Porcupine. Wright in his prospecting around the lake located visible gold in narrow quartz stringers; and some of his claims subsequently became the Wright-Hargreaves Mine. Early in January of 1912, Harry Oakes and the Tough brothers staked the Tough-Oakes on particularly spectacular surface showings. Later, Oakes moved westward and staked the Oakes claims which afterwards became the renowned Lake Shore, now the richest gold mine on the American continent.

Meanwhile, most of the ground along Kirkland Lake and beyond was staked with what seems to have been a singular lack of noise. The field was discovered quietly and almost prosaically. There must always remain the fact that the men in question penetrated into a district that had received little notice, and that they were all there for the definite object of finding gold. There are no picturesque legends regarding its discovery, and the usual run of glamorous incidents are missing.

Naturally there was quite an influx of prospectors; but there does not appear to have been any very feverish activity. There were no great hummocks of gold-seamed quartz; no indications that Kirkland Lake was going to be famous; and it is doubtful whether those that were associated with the area in the very beginning ever visualized, even in their wildest dreams, where those narrow quartz-filled cracks would lead.

II

Which Sketches Its Development

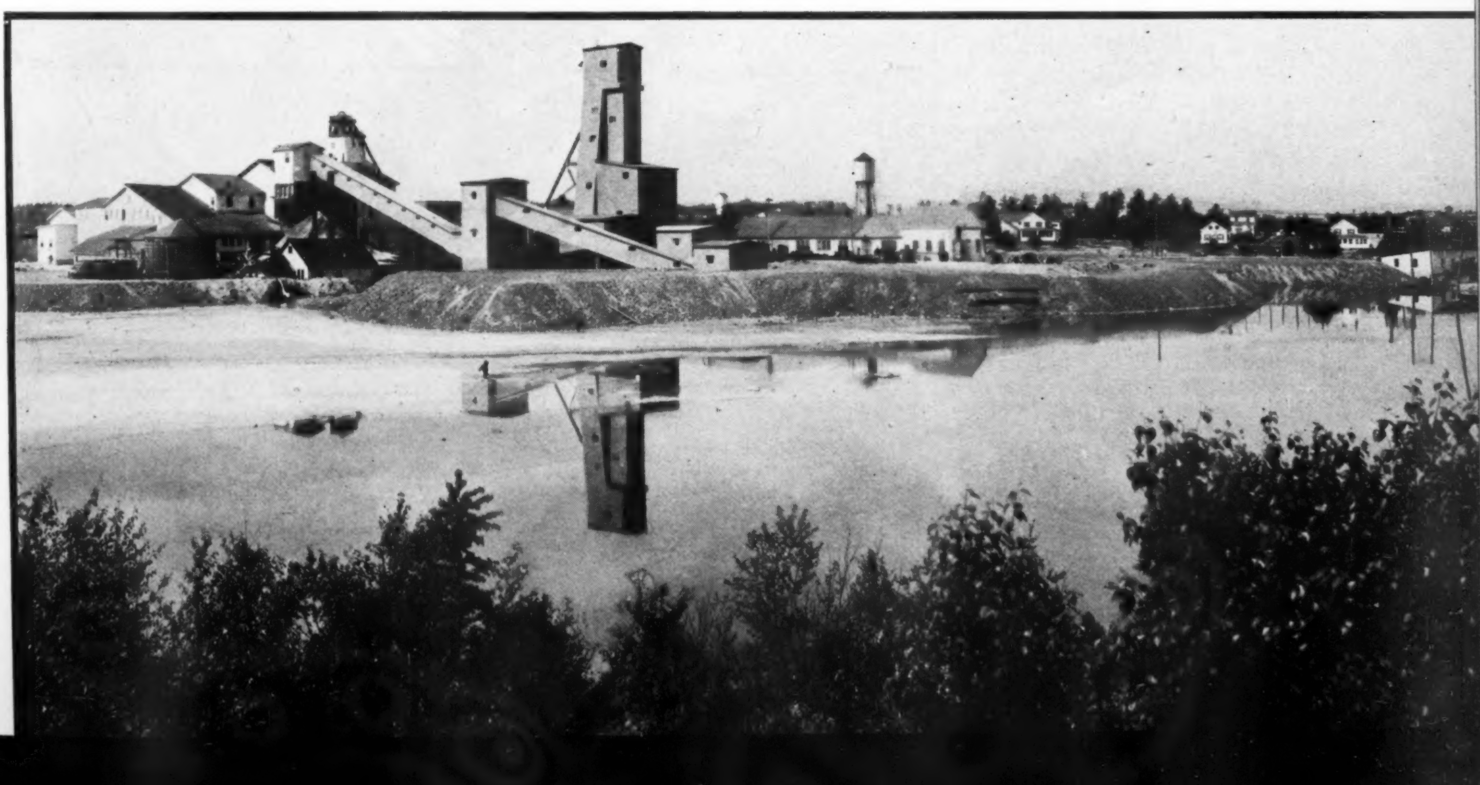
"If you can force your heart and nerve and sinew
To serve your turn long after they are gone"
—Kipling.

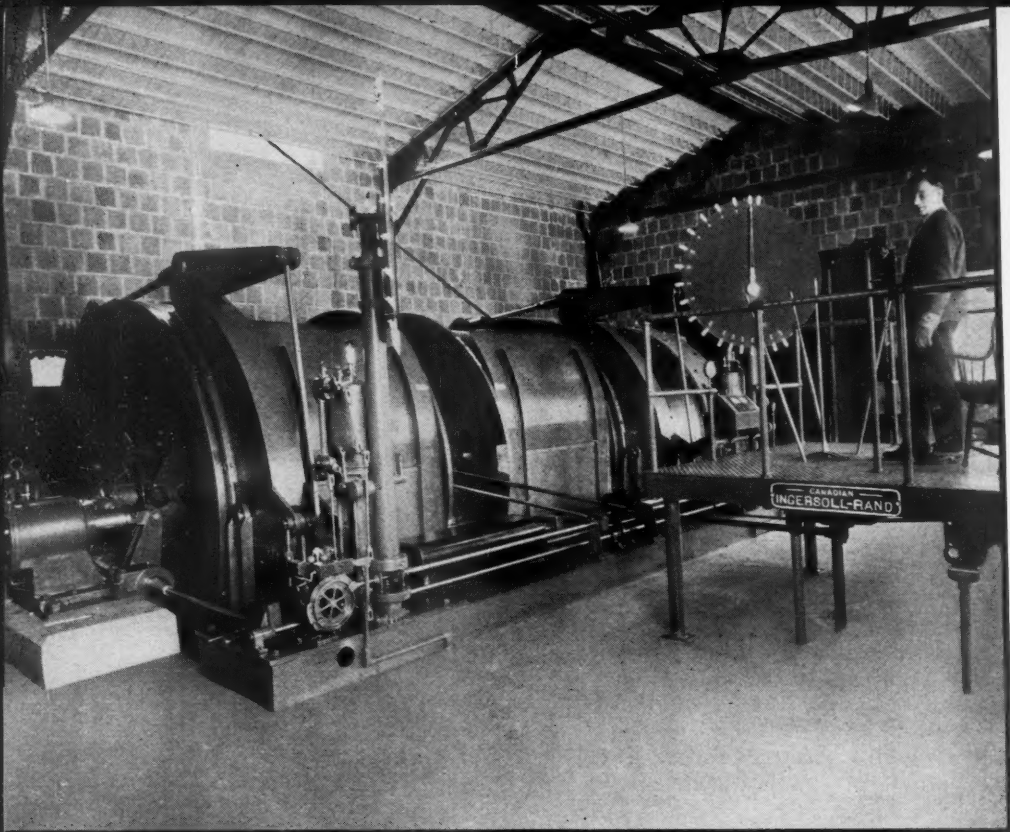
AFTER the initial splurge of activity, one of those peculiar lulls which seem to be so characteristic of new mining fields (but which was strangely lacking in the case of Porcupine) set in, for in spite of the spectacular nature of the Tough-Oakes surface showings the district did not attract much outside attention. It is always difficult to account for these lulls, and it is particularly hard to understand this apathy in connection with Kirkland Lake, the discovery of which followed so closely upon that of Porcupine. It is true that the veins were narrow and possibly looked commonplace after Porcupine; but those were optimistic times when imagination was easily fired.

As events turned out, there were many heartburnings before the riddle of Kirkland

WRIGHT-HARGREAVES MINES

The initial discovery at Kirkland Lake was made by W. H. Wright in 1911. Some of his claims became the Wright-Hargreaves Mines, Ltd., which has produced upwards of $30,000,000. It was the finding on this property of another vein 550 feet north of what had been considered the main lode that solved the riddle of Kirkland Lake's geology and led to the great era of prosperity that is now at its height. With money which he received for options on some of his holdings, Mr. Wright helped Harry Oakes keep the Lake Shore going during its lean days. The latter is said to be the richest gold mine on the American continent.





LAKE SHORE HOIST

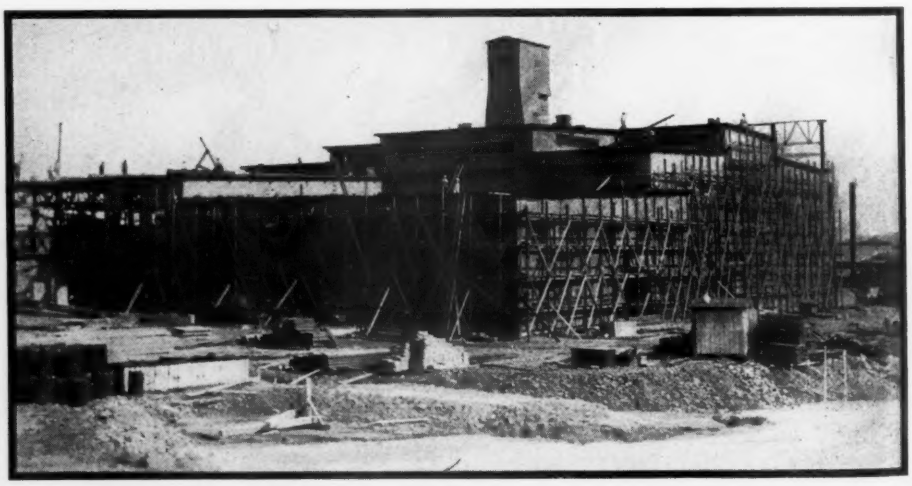
This 1,350-hp., direct-connected electric hoist, the first and largest of its kind to be wholly designed and built in Canada, raises ore to the surface from a maximum depth of 4,200 feet. It has drums 10 feet in diameter, uses 1½-inch cable, and has a rope pull of 45,000 pounds.

Lake was solved; but in the early days people did not know this, and the future was just whatever imagination cared to make it, so it must always be something of a puzzle why Kirkland Lake was not treated to an overdose of optimism. However, the fact remains that it was not, and very little was done during 1912 except upon the Tough-Oakes claims. Trenching was started late in February, and within a few hours No. 1 Vein was found. At the spot of location it was 4 feet wide and assayed $200 to $400 per ton. After the snow was gone, more high-grade was discovered in what was called No. 2 Vein. During the year some of this ore was sent to Cobalt to be milled, and gave returns from $150 to $1,200 per ton. No. 3 Vein was also trenched, and many assays ran from $200 to $300 per ton across widths of from 18 inches to 3 feet. All this was spectacular enough to suit anyone; but nothing much happened, except that during the year the Tough-Oakes Company was formed.

Meanwhile other stakers in the district were busy trenching and stripping their holdings. It is worth noting that there was no capital coming into the district; the men were forced to finance themselves during that period. Time has a knack of glossing over difficulties, and its mellowing influence smoothes down the memories of hardship, which is one of the reasons why the members of that hardy band of pioneers smile today over the incidents of the lean days when Kirkland Lake was cutting its teeth. There is also another reason, and that is that among them were men who, as subsequent happenings have proved, were of extraordinary caliber. Some of them have traveled royal roads since the year 1912, as we shall see as this chronicle progresses.

During 1913 events began to materialize. Kirkland Lake Gold Mines was incorporated to exploit the McKane property, and for several years this was the most westerly producing mine in the area. During the same year Teck-Hughes Gold Mines was formed to operate the Orr and other claims, and Sylvanite Gold Mines which took in part of Wright's claims and the Robbins holdings was also organized. Things were looking better for the new camp. Kirkland Lake Gold Mines struck rich surface showings by trenching through 20 feet of overburden along the strike of the outcrops on the adjoining Teck-Hughes. Shafts were sunk and underground exploration started. Then, just as matters began to take on a more rosy hue, disturbing news began to seep out. Work at the Teck-Hughes, Kirkland Lake Gold, and Sylvanite was disappointing. There was some ore, but not much of it, and the general behavior of the deposits was hard to understand. The first of the heartburnings was beginning to be felt.

At this juncture it is perhaps advisable to glance at the relative positions of the properties involved in order that we may follow the course of events. At the westerly extremity of the then known ore zone were the holdings of Kirkland Lake Gold, and immediately adjoining to the east were those of Teck-Hughes Gold Mines. Next along the strike was the property of Oakes, followed by that of Wright. East of Wright's claims, and still on the strike, were the holdings of Sylvanite, which were butted in turn by the Tough-Oakes and Burnside. Thus, as the picture of 1913 is unfolded, we see that underground operations were being carried out on the two most westerly properties with discouraging results. Oakes was working on his claims personally, with his efforts concentrated on what eventually became known as the South Vein. East of Oakes some work was being done on the Wright claims, while Sylvanite, on the other side of the latter, was getting exactly nothing. Meanwhile, at the extreme east of the string, the Tough-Oakes was having a grand time producing high-grade ore and making everyone else's mouth water. Two



A UNIQUE RECONSTRUCTION JOB

In 1933 a new mill was built on the Wright-Hargreaves property under unusual circumstances. The structure was erected over and around the old mill without interfering with its operation. New units of equipment were substituted for existing ones while the plant was running, and the complete change-over was made with the loss of only 24 hours of production. The picture shows construction underway.

A FAMOUS HOSTELRY

Everyone identified with the early period of Kirkland Lake was familiar with Ash's Hotel. Many whose names are now illustrious spent their leisure hours there. Of distinctive finish (its exterior walls were sheathed with galvanized iron), it acquired the title of the "Ash Can." As was his habit, the genial proprietor, James Ash, was reclining in a rocking chair on the veranda when this picture was taken.

carloads of ore from that property brought in returns amounting to $17,000.

It should be remarked that during 1913 the Wright claims were under option to R. Cartwright and a vein was uncovered lying 550 feet north of what was then thought to be the main fracture. It was 5 feet wide, and a small shipment obtained from a shallow shaft sunk upon it assayed well over $300 per ton. In spite of this the option was allowed to lapse, and the properties remained idle for some time. The discovery of this north vein was important, as will be seen later. Thus 1913 closed on a not altogether optimistic note.

The year 1914 saw the advent of Cobalt interests in the new field, and they continued to play quite a part in the development of the district from then on. Nipissing Mines optioned the Teck-Hughes and threw its resources into the property, which was put under the management of Harry Kee; Beaver Consolidated Mines, Ltd., took an option on Kirkland Lake Gold Mines; and Harry Oakes organized Lake Shore Mines, Ltd., which was also an event of the highest significance.

The story of Harry Oakes and the Lake Shore Mine is one of the greatest romances of mining in all the world. It is the only case known to this writer in which the original staker of a mine has retained control of it throughout all its history. Usually, the discoverer sells his claims to those that will undertake the financing of an operating company. Those who specialize in financing generally, and quite properly, drive hard bargains, and the discoverer, who more often than not has had plenty of heartbreaks and found the road long and hard, is glad to dispose of them for a cash consideration and a very minor stock interest in the operating company.

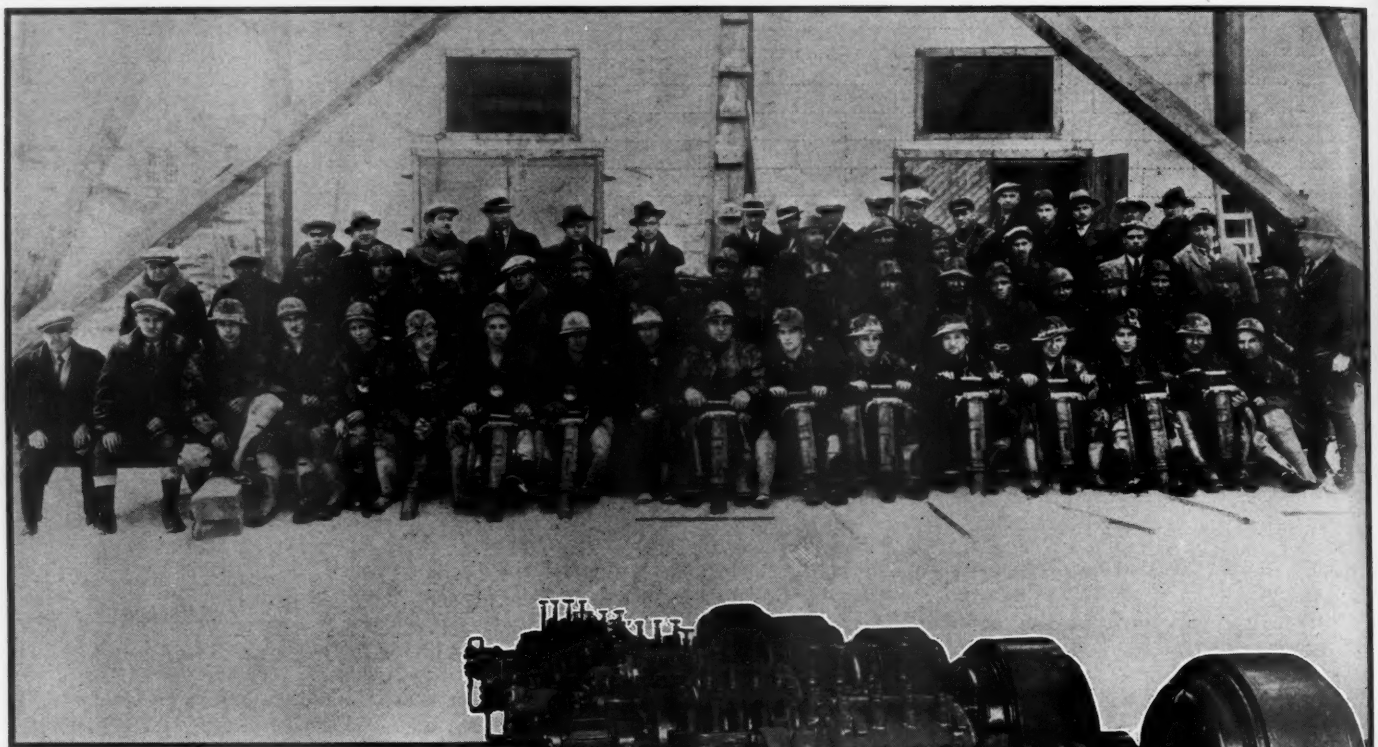
That was not the case with Oakes. He financed his preliminary work himself, and only he and those associated with him realize what a job that was in the days when, as he himself told a passerby, he didn't know whether he was "making a mine or a potato patch." And when the time came for more intensive exploration he formed his own company, turned in his own claims, and he and Wright invested their own money. The latter put in what he obtained for options on his own property. All this is a splendid example of the faith these men had in a district that was to become so famous.

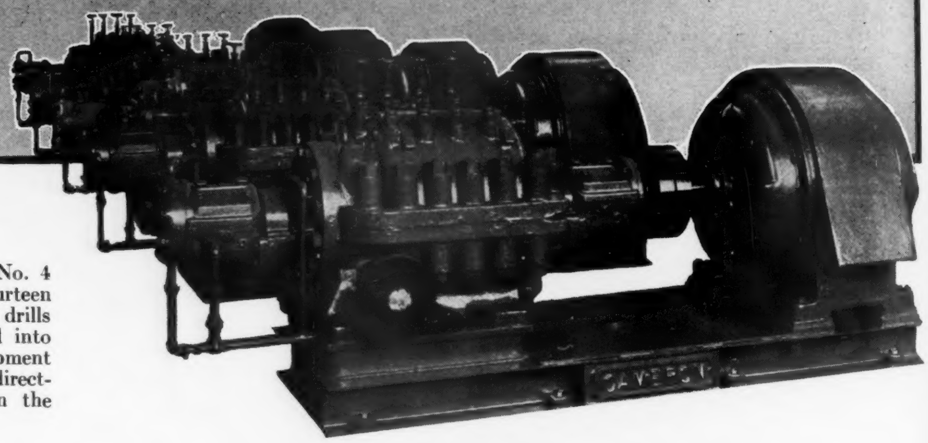
The struggles of those early days constitute an epic of belief and courage that would be hard to surpass. The men had to procure money in the face of apathy and almost active antagonism; and even when the Lake Shore produced ore, and capital for a mill was wanted, it was obtained by selling stock below 35 cents a share. When this last financing was being carried out, Wright was in France doing his bit in the great World War—the devastating effects of which, among other factors, contributed to the difficulties confronting those engaged in the task of developing Kirkland Lake. In a personal note to the writer, Wright stated that he sometimes marveled how Harry Oakes kept the mine going; but he did, and in the course of time the Lake Shore became a wonder mine. It made those closely associated with it rich almost beyond the dreams of men; but through it all—during the struggle of the early years when many a tempting bait must have been held out to him to relinquish control, when money withheld in the hope that the difficulties he was facing would force him to make sacrifices, and when the mine was climbing to fame, Harry Oakes kept control and still holds it, and with him on his board of directors are some of the men who were with him in the lean and hungry days before Kirkland Lake came into its own.

And they were lean days, because 1914, like 1913, was not very propitious in the history of the district. Nipissing worked all year on the Teck-Hughes but could not find anything very exciting, and finally became discouraged, relinquishing its option in March in 1915. Beaver Consolidated worked on Kirkland Lake Gold with results

1,000 FEET UNDERGROUND

Canadian mines are among the leaders in efficiency and economy, largely because of their excellently trained man power and the widespread utilization of mechanical aids. This picture shows an "electric mule" and train of cars in the Wright-Hargreaves Mine.



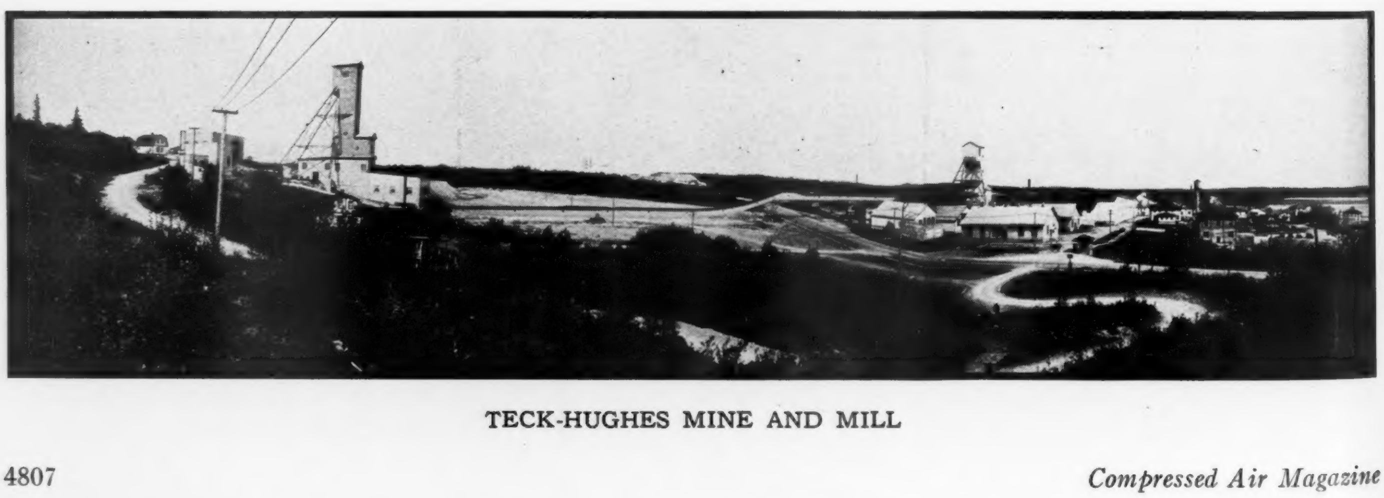


RECORD SHAFT SINKERS

This crew set a new mark in sinking the No. 4 Wright-Hargreaves shaft. After being fourteen months in that hard service, the N-82 sinker drills which the men are holding were converted into drifters and assigned to underground development work. At the right is a shop view of the five direct-driven, 5-stage, electric pumps installed in the pumping station which serves this shaft.

that were not conspicuously successful but which, nevertheless, were not quite bad enough to make it give up. The Lake Shore Mine worked away steadily on the No. 1 (or South) Vein. The Wright claims were idle, and Sylvanite operations were desultory. The Tough-Oakes, however, was still busily engaged in making history for itself by shipping during the year 212.79 tons of ore with a value of $781,590.38, or $350.53 per ton. A 5-stamp mill was also in operation; and the property was supplied with electric power from midsummer onward.

During 1915 the Beaver Consolidated finally took over Kirkland Lake Gold and incorporated Kirkland Lake Gold Mine Company, Ltd. Likewise, interests connected with Buffalo Mines, Ltd., a Cobalt company, obtained control of the Teck-Hughes, and in March the first real mill of the district came into production on the Tough-Oakes. It was a 100-ton cyanide plant, and the extraction per ton for the year was $21.21. It is worth noting here that the Tough-Oakes Mine was exercising a certain influence upon the rest of the camp. It was the only producing mine; it had a definite spectacular aspect from the start; and there was a very natural tendency to view the possibilities of the rest of the camp from Tough-Oakes precedents. But even then the mine was beginning to exhibit certain qualities that did nothing to imbue the other operators with any great sense of security. The veins were comparatively narrow; but the ore shoots were very high grade. It was found that the ore was abruptly cut off by a fault to the westward, and there was some uncertainty. The riddle of Kirkland Lake was not yet solved, and the solution, when it did come, was not the Tough-Oakes at all.



TECK-HUGHES MINE AND MILL

DESOLATION

Night on a northern lake. Scenes such as this are familiar to the men who have discovered and worked in Canada's mines and to the legions who continue to push farther and farther northward in the Arctic Circle in their quest of precious metal.

In 1916 a 650-ton mill was started on the Teck-Hughes. Wright-Hargreaves Mines, Ltd., was formed and active development commenced. Elsewhere work was proceeding steadily with medium results, but there was no cheering. The Tough-Oakes produced more than $700,000 and employed about 300 men, but it is noteworthy that extraction dropped to $18.85 per ton.

During 1918 several things happened that were to have a great bearing upon the camp. Early in the year the mill at the Lake Shore Mine was put in service; but more important still was the discovery of the North Vein on that property. This vein, which was in what was later proved to be the main break of the district, was being explored on the Wright-Hargreaves. Its strike carried it into the waters of Kirkland Lake, and its continuity was therefore a matter of surmise. Development at the Wright-Hargreaves showed it to have a remarkable strength of structure that gave every promise of continuity along the strike. It was this fact that caused the Lake Shore to run a crosscut out under the lake from the south-vein workings with the object of determining whether the Wright-Hargreaves vein extended into its ground. It might be mentioned here that the South Vein, while a good vein, did not exhibit any remarkable high-grade properties.

Early in 1918 the Lake Shore crosscut struck the North Vein, and its general appearance at the point where it was cut was such that steps were immediately taken to explore it. Results were so remarkable that work was speeded up on the Wright-Hargreaves and the Teck-Hughes. This North Vein has been, and still is, the main source of production of the Kirkland Lake District. It is characterized by ore shoots of great length, tremendous width, and spectacular grade. It has made the Lake Shore a wonder mine; and it is the same vein system that has been so productive at the Teck-Hughes and Wright-Hargreaves.

The natural inference from all these facts would be that the district was well on its way to its ultimate destiny. Electric power was available; the general structure had at last been solved; ore was being rapidly developed; and some comprehension of the future of the camp was being gained. After all, seven years had elapsed since its discovery; but there were still troubles in store for it.

As an antidote to any undue optimism that the finding of the North Vein might have caused, the Tough-Oakes was closed down late in 1918, and this naturally did nothing to aid the district in the eyes of the general public and the mining fraternity. There were lots of people who were ready to point out that while there might be rich ore in the North Vein at Lake Shore there had also been rich ore at the Tough-Oakes. As a result, caution was the order of the day. In addition, the high cost of supplies was a drag on successful operations; and to crown it all, labor troubles entered to complicate an already rather complicated situation. Thus, even in 1920, with four mills at work in the field, the stock of Lake Shore could be bought for a dollar a share, and Teck-Hughes was quoted as low as eight cents.

Actually, however, the camp had by this time passed through most of its vicissitudes. The nature of the ore bodies at depth was beginning to be understood, their strength and consistency could not be ignored, and from 1920 Kirkland Lake started forward on the road of expansion along which it has traveled without interruption to its present commanding position as the leading gold-producing district in the Dominion of Canada.

This is the fifth of a series of articles by Mr. Rowe. The sixth will appear in the September issue.

DRIFTING UNDER A LAKE

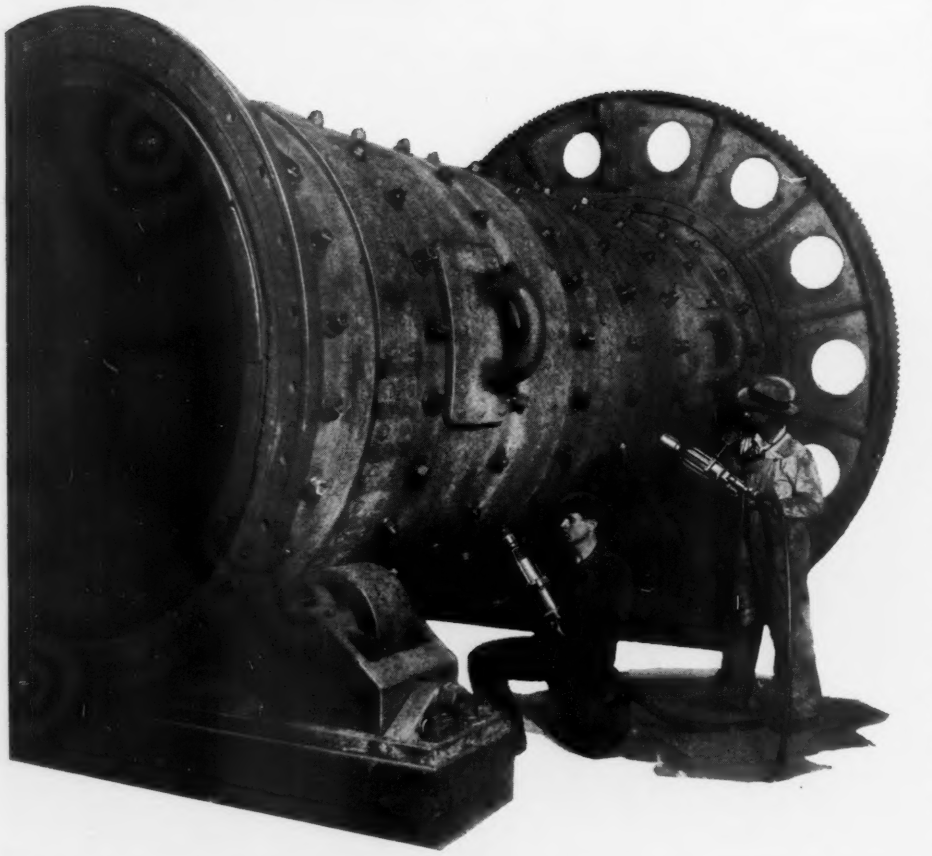
Following the discovery on the Wright-Hargreaves property of what is now the principle vein, which lies north of the discovery lode, steps were taken to learn whether it persisted in the Lake Shore Mine. The strike carried the vein underneath Kirkland Lake, thereby precluding surface explorations. In this situation, the Lake Shore drove a crosscut from its existing underground workings and was rewarded by striking excellent ore. This view shows an N-70 drifter operating beneath the lake.

Pneumatic Wrench of New Design

OPERATING efficiency and adaptability are essentials in portable tools, and safety and ease of handling in all kinds of places, including those hard to reach, are equally important factors. The air-driven Pott impact wrench developed by Ingersoll-Rand Company, New York, N. Y., has these virtues. It is light and compact, either reversible or nonreversible, and is based on a new principle that is revolutionary in the field of pneumatic wrenches. The principle is that of rotary impact.

The machine consists of an air motor and of four major parts, as illustrated. The motor is of the multi-vane type and drives the wrench unit, which includes an accumulator, a hammer, and an anvil, all enclosed in a hammer case that is air cooled to prevent excessive heating of the accumulator. The chuck is attached to the anvil. The accumulator is of special rubber, cylindrical in form, and interposed between the motor and the hammer.

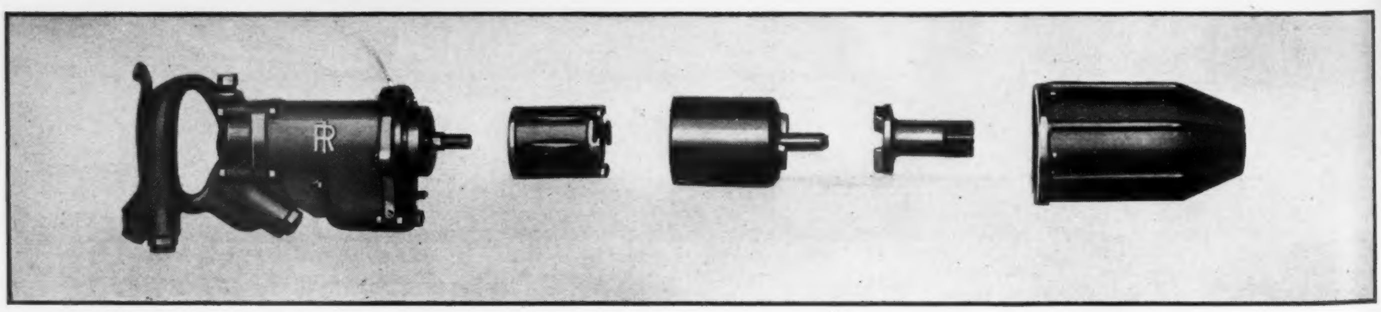
In operation, the motor drives the accumulator which, in turn, drives the hammer and, through jaws on the face of the latter, the anvil. All these parts rotate at the normal motor speed when a nut is being applied and is free-running. When it starts to tighten, however, the torque from the motor twists and shortens the accumulator until the jaws on the hammer and the anvil are disengaged. At that instant the accumulator untwists and lengthens, with the result that the hammer is forced back into engagement with the anvil and, at the same time, delivers to it a powerful rotary impact. There are two impacts for every revolution of the motor. In other words, in the case of a machine running 800 to 850 rpm. there would be 1,600 to 1,700 impacts per minute.

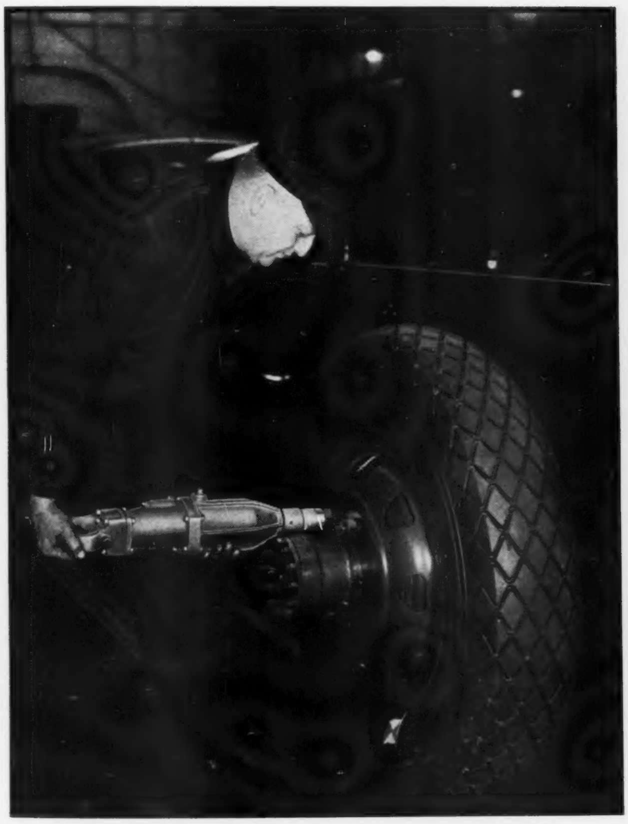


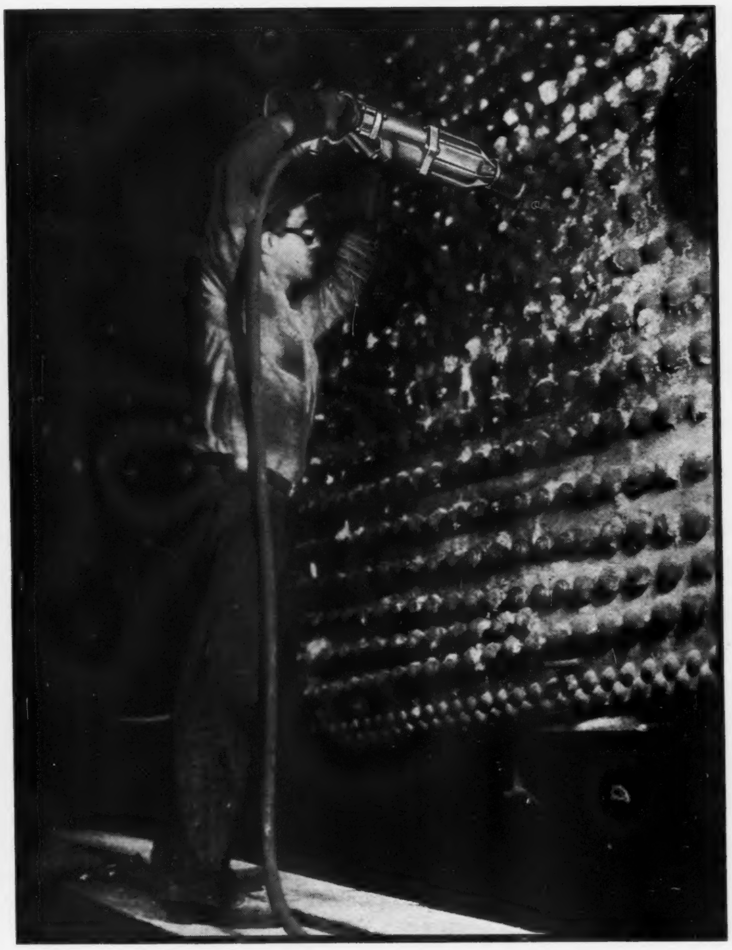
The Pott impact wrench comes in two sizes, and there is a reversible and a nonreversible type available in each size. The latter are suitable for running on nuts in assembly-line and general bolting-up work, while the foımer can be used both in applying and removing operations. It is claimed that this new wrench will loosen and remove nuts that no other type of pneumatic wrench can start.

Reversing is effected by shifting gears. This form was decided upon because of economy in air consumption—a nonreversible multi-vane motor requiring about one-third less air than a reversible motor of equal capacity. Furthermore, reversing by shifting gears constitutes an additional factor of safety because it prevents accidental reversing.

The smaller of the two sizes of impact wrenches are known as the 501 nonreversible and the 511 reversible. They weigh, less chuck, 13¾ pounds, are 16¼ inches long over all, and are recommended for removing and applying nuts on bolts ¾ inch in diameter and less. The larger are the 503 nonreversible and the 533 reversible. These weigh, less chuck, 23½ pounds, are 19¼ inches long over all, and are suitable for removing and applying nuts on bolts up to 1¼ inches in diameter. Chucks of special alloy steel are available in all standard sizes, and special chucks to fit any nut or staybolt cap within the capacity of the tool can be furnished.







POTT IMPACT WRENCHES SERVE MANY INDUSTRIES

On the opposite page they are seen at work in a shipyard bolting up the hull plates of a tanker (top), and in a mine helping to reline a ball mill (center). At the bottom are the structural features of the tool: air motor, accumulator, hammer, anvil, and hammer case, following in sequence from left to right. On this page, top left, the wrench is shown removing large locomotive wash-out plugs, usually a 2-man job. Right—In an oil refinery running off corroded nuts without difficulty. Bottom, left—On the assembly line in an automobile plant mounting the brake housing on a wheel. Right—Removing flexible staybolt caps from a locomotive. The ease and safety with which the tool can be handled even at arm's length enable the operator to cover a large area without shifting his working platform.

New Vacuum Process of Die-Casting

THE USE of vacuum in the manufacture of die castings is a departure in foundry practice that may have far-reaching effects, judging by the results achieved by the Aurora Metal Company, Inc., Aurora, Ill. That company has developed and is employing a process whereby it is possible to make die castings of aluminum-bronze possessing all the desirable properties inherent to certain of its alloys. Heretofore, aluminum-bronze parts produced by the accustomed methods could not be depended upon to have those qualities largely because of inclusions of aluminum oxide within the body of the metal. But this can now be overcome, it is claimed, by reversing the usual procedure of forcing the fluid mass into the die under pressure.

The Aurora Metal Company process is a patented one, and by it the alloy is drawn into a steel die by suction induced by a vacuum pump. In that company's plant, the die is spotted over the pot of the melting furnace by an air hoist and lowered until the gate at the bottom of it extends down into the molten metal for several inches. With the vacuum-line connections made, the upper part of the die is then evacuated and the alloy sucked in through the gate in one operation, the metal rising smoothly and continuously into all the cavities. It should be pointed out here that the design of the die is an important consideration, for it must be such that the thinner sections of the casting will not solidify before the die is completely filled.

The extent to which the dies are evacuated varies with the design of the casting and the height of the die cavity; but, in any case, sufficient air must be exhausted to cause the metal to rise uninterruptedly and to flow to every part of the die so as to assure a perfect and homogeneous product. At the plant in question the vacuum induced in this work ranges from 5 to 25 inches of mercury—an index of the diversity of the aluminum-bronze castings turned out there. They are both simple and intricate in form, and weigh from a fraction of an ounce to 30 pounds.

The alloy entering into the manufacture of these Stronger-Than-Steel Die Castings, as they have been named, is composed of 89 per cent copper, 10 per cent aluminum, and 1 per cent iron. However, to meet special requirements, changes in the physical properties of the castings can be effected by slightly varying the composition. The melting point of the metal is approximately 1,950°F., but it is cast at a temperature of from 2,050 to 2,300°, depending upon the nature of the product. A thin casting with a small sprue hole, for example, calls for a higher temperature than does a thicker one with a larger sprue hole.

The castings as they come from the dies have a tensile strength of more than 80,000 pounds per square inch and a hardness of 130 Brinell. If desired, however, these can be increased subsequently to 100,000 pounds per square inch and 260 Brinell, respectively, by heating the part to 1,700° and quenching in water. Furthermore, it is possible to vary the hardness between the limits given to meet differing mechanical needs. Other characteristics of the aluminum-bronze are: high resistance to shock, abrasion, and corrosion, and exceptional wearing qualities.

Courtesy, Machinery

CASTINGS MADE BY THE NEW PROCESS

The outstanding advantages claimed for the vacuum die-casting process are that the impurities at the top of the melting pot are prevented from entering the die, and that the negligible quantity of aluminum oxide that is formed on the surface of the metal is deposited as a thin film upon the walls of the die cavity. Shrinkage of the castings so made is confined entirely to risers in one or more pockets at the top of the cavity. This is achieved by keeping the risers in a liquid state, free to flow back into the die so as to compensate for any shrinkage that may take place during the process of solidifying. When the casting has cooled it is removed from the die, and the risers and sprues are cut off for re-use. There is little or no waste because, with the exercise of proper precautions, there are few rejects, and these, together with the scrap metal, are thrown back into the crucible for remelting and recasting.

Another advantage attributable to the vacuum method is the accuracy with which the castings come from the dies, aside from their smoothness and freedom from blow holes. Generally, tolerances equal to half of 1 per cent of the linear dimensions can be maintained, although greater precision is attainable at increased cost. This means that parts that must conform closely to dimensions need not be machined from blocks of steel, but can be cast. Where machining is essential it can be done at a minimum expenditure of time and labor. Hand tooling and finishing are usually eliminated.

Castings that were formerly made of materials that are inherently weaker than aluminum-bronze are now being redesigned by the Aurora Metal Company and given smaller cross sections, thus lessening bulk and sometimes making for required grace of line that is hard to achieve when it must be combined with strength. Likewise, it is casting in one piece what used to call for the manufacture of two and more pieces, obviating fastenings and possible weaknesses in the finished article.

The process can be employed in connection with sand cores, permitting the casting of certain complicated parts that cannot be produced with moving cores in the dies. It also enables casting aluminum-bronze around other metals introduced in one form or another into the dies. Thus, a bronze sleeve can be made an integral part of an aluminum-bronze die casting. Although the melting point of the former is lower than that of the metal being cast, still the latter solidifies immediately upon reaching the insert, thus assuring a firm bond.

It should be added in conclusion that the castings made possible by this new method are not offered as substitutes for white-metal castings, sand castings, forgings, etc., which are giving satisfactory service. They are mainly intended for such applications that necessitate strong parts, where reduction in machining costs will be worth while, where resistance to corrosion is a vital factor, where it is desirable that aging effect no change, and where heat that might measurably reduce the strength of other materials must be taken into consideration.

GEOPHYSICS AIDS ROADBUILDERS

GEOPHYSICAL methods of sub-surface exploration, which are widely used in the petroleum and mining industries, may be adopted by highway engineers for the purpose of securing advance information about sections to be excavated. Following numerous tests by various state highway departments, the United States Bureau of Roads has conducted studies along the same lines. The results indicate that two types of geophysical investigation are effective for determining the character of underground materials.

The resistivity method, which is based on the resistance which the earth offers to the transmission of an electric current of known strength, has been employed in several states during the past few years in connection with grading operations, fills through swamps, and in ascertaining the location and extent of gravel deposits and quarry material. The seismic method, which classifies materials according to the speed with which they transmit sound waves set up by explosions, seems to be even better adapted for highway building, judging by the statements of the Federal investigators.

Results obtained by using the resistivity method for preclassifying excavation materials on Missouri State Highway projects are enlightening. As reported by R. C. Schappler and F. C. Farnham, it was found that without the aid of geophysical measurements an error of nearly 13 per cent was made in 1931 in estimating the amount of solid-rock excavating on 25 projects. In 1932, on the other hand, on a like number of similar jobs, and using resistivity tests, the error was only about 1 per cent. Fifteen of the projects, in both instances, were located in the difficult Ozark region. In that area the 1931 estimates showed an average error of more than 24 per cent, being too low. The 1932 error was but around 3 per cent, and on the high side.

In commenting upon the studies recently made, E. R. Shepard, research engineer of the Bureau of Roads, writes in *Public Roads:* "Tests by the Bureau over a period of months on known formations around Washington indicate that, for determining the presence and location of consolidated rock, the seismic method is more reliable and accurate and in other ways superior to the resistivity method."

Sand, clay, gravel, and other nonrigid materials transmit sound waves at velocities of from 1,000 to 6,000 feet per second, whereas rigid materials such as rock transmit them at speeds of 16,000 to 20,000 feet per second. The seismic method, then, offers a direct means of measuring the rigidity, which is the property that most interests the highway engineer. It is not so suitable as the resistivity method for distinguishing between the various kinds of soft material such as sand and clay; but such information is of small consequence for the purpose under consideration. The essential thing is to be able to determine, with reasonable accuracy, how much material will have to be drilled and blasted before it can be handled by power shovels. Until now, the only way of finding this out has been by boring test holes.

Simplified and less costly apparatus has been developed for making seismic investigations of the relatively shallow depths with which highway builders are concerned.

SAN FRANCISCO SUBWAY

HAVING successfully put under construction two gigantic bridges to link the city closer to its environs, San Francisco is taking steps further to speed up local travel by building a subway beneath its streets. The scheme calls for expenditures of $56,200,000. It provides for 7¾ miles of underground lines which will be designed to operate in conjunction with a 3-mile surface section running at high speeds.

The movement is an outgrowth of the bridge-building program. Upon the completion of the Trans-Bay and Golden Gate spans, city workers residing in Oakland, Berkeley, Alameda, and Marin County will be able to go to and from their distant homes in shorter time than people living in many residential sections of the city itself. Naturally something will have to be done to correct this inequality if San Francisco is to retain its population; and the projected subway has been offered as a possible solution by Edward G. Cahill, manager of utilities. The plan contemplates constructing the subway in three sections. Application has been made for a Federal loan to finance the work.

A TRAVELING SCHOOL

THE Montana School of Mines has launched a novel idea in education that seems certain to be popular. The institution is sending out over the state a traveling school to give a brief course in the essentials of mining and prospecting to those that cannot visit the campus. An automobile serves as both classroom and laboratory. It stops a week at each town where mining is an important activity. Great Falls, Helena, and Virginia City were visited during the first three weeks in July.

The course includes lectures on methods of prospecting and on the occurrence and treatment of ores. These are supplemented by laboratory demonstrations of mineral determination and methods of sampling and assaying ores. Particular stress is laid upon mining methods that are applicable to the section where the school is being held. Suggestions are made concerning the equipment required for small mining ventures; and the assaying outfit carried is the type recommended for a small property.

At Butte, the home of the School of Mines, a 6-week prospectors' course is conducted annually; but it was believed that there was need also for this new form of itinerant instruction.

FLOTATION, by A. M. Gaudin, Research Professor of Ore Dressing at the Montana School of Mines. An illustrated book of 525 pages, published by McGraw-Hill Book Company, Inc., New York City. Price, $6.00.

ALL knowledge concerning the concentration of ores by flotation has been acquired in less than a quarter-century. Only 25 years ago the process was considered of doubtful worth, yet it is now universally approved and practiced. By reason of the very modernness of flotation it has been possible to compile and to record virtually all that is known about it. Even so, the thoroughness with which Professor Gaudin has done this impresses the reader. Nothing has been left out, nothing has been glossed over: the student and the practical mill man will both find well-nigh every phase of flotation covered in this book.

The history of flotation, the theoretical considerations on which it rests, the reagents and machines it employs, and the methods in use in various parts of the world on all sorts of ores, are all set down. The universality of the information given has been already acknowledged through the decision of the Soviet Government to translate it into Russian.

Professor Gaudin has been a member of the Montana School of Mines faculty since 1929. Prior to that time he was at the University of Utah. Before going west he served as lecturer in mining at Columbia University in association with Arthur F. Taggart, noted ore-dressing authority, to whom his book is dedicated.

The introduction was prepared by Theodore J. Hoover of Stanford University. One who peruses Professor Gaudin's contribution cannot but agree with Dean Hoover that "One of the outstanding merits of this book is that it much more fully than any previous attempt gives a practically complete exposition of the scientific principles underlying a process which is treating millions of tons of ore every year."

HANDBOOK OF CHEMISTRY AND PHYSICS, Nineteenth Edition. A handbook of 1,900 pages, published by Chemical Rubber Publishing Company, Cleveland, Ohio. Price, $6.00.

THIS handbook is packed with tables and information for the chemist and physicist. The general features and scheme of arrangement of former editions have been retained, with a few minor rearrangements that make for greater ease of finding and using the material. Colored index pages have been inserted throughout the book, dividing it into sections. Material on all branches of chemistry and physics and the closely allied sciences has been included. Constants and formulae are given for both sciences, together with mathematical and conversion tables adequate for accurate computation.

One of the more important new tables is a collection of X-ray crystallographic data for more than 1,300 substances covering elements, inorganic compounds—including alloys and minerals—and organic compounds. The thermodynamic properties of ammonia and other refrigerants are given in considerable detail in a collection of tables covering some fourteen pages. A new form of table for determining the density of moist air provides a quick method of obtaining this quantity from the temperature, pressure, and dew point with sufficient accuracy for most purposes. Several new tables appear in the mathematical section. One group affords added convenience in finding the functions or their logarithms for decimal fractions of a degree or for angles and radians, while another facilitates the mathematics of finance. Other important tables have been revised.

Alcoa Aluminum and Its Alloys, published by the Aluminum Company of America, Pittsburgh, Pa., is described by that concern as "the most comprehensive booklet on aluminum that the company has for distribution." The greater part of this 92-page booklet consists of general information concerning aluminum and its principal alloys. The facts are those that the technical man will find useful, but they are presented in language that anyone can understand. Supplementing this discussion is an appendix containing tables showing the physical properties, compositions, typical mechanical properties, dimension tolerances, and available commercial sizes of the various aluminum alloys and products made from them.

The University of Tennessee, Knoxville, Tenn., has published the 27th edition of the *Manual for Engineers*. Probably the most weighty comment that can be made concerning it is that it has survived so many editions. While it is designed primarily for engineers, it contains considerable data of value to businessmen and to students. It consists mainly of tables and of other condensed information useful to those charged with the design or actual building of structures. One of its principal virtues is its vest-pocket size, which permits it always to be carried. The information was compiled by the members of the College of Engineering at the University of Tennessee. The book, of 135 pages, is published by the University of Tennessee Cooperative Book Store. It sells for 75 cents, postpaid.

The 1930 population of Utah was 508,000, and of this number 70,000 persons were directly dependent upon mining for their livelihood. The present figure probably exceeds that, for mining activity has increased. The payroll of the mineral-working industries is one-third of the state's total; supplies for the use of such companies average a value of $50,000 a day, and 80 per cent of the state's freight tonnage comes from its mines. The three items just mentioned—wages, supplies, and freight—amount to $85,000,000 a year. The foregoing are some of the facts contained in an attractive 53-page booklet, *What Mining Means to Utah*. It was first published in 1929, and met with such approval that it was reissued this year. It was designed primarily for the consumption of Utah residents; but makes worth-while reading for anyone interested in mining, particularly because it presents a brief summary of the activities of the principal operating companies. The book was published by a subcommittee of the mining committee of the Salt Lake Chamber of Commerce.

Ingersoll-Rand Company, 11 Broadway, New York City, has available for free distribution to those interested a catalogue descriptive of its new Type XPV steam-driven air or gas compressors. Within the covers of this 48-page bulletin are numerous illustrations which show the structural features as well as various installations of these latest XPV's. They range in size from about 50 to 150 hp., and are designed with steam and compressor ends to meet any pressure condition.

The Statistical Research Bureau, 108 West 6th Street, Los Angeles, Calif., has just published a standard reference work on mines in the United States entitled, *The Mining Manual for 1935*. It is a book of 320 pages and contains facts and figures about more than 500 mines and mining companies, and particularly about those engaged in the production of gold and silver. An added feature is a glossary of mining terms. The manual should prove a valuable addition to the shelf of any mining engineer, mine manager and director, machinery manufacturer and distributor, banker, library, etc. Its price, postpaid, is $2.00.

Industrial Notes.

Oil tankers constitute one sixth of the merchant tonnage of the United States.

At the U. S. Forest Products Laboratory in Madison, Wis., certain species of wood are being rapidly seasoned by soaking or boiling them in a chemical solution. No kiln-drying is required.

Parallel plates of sheet iron, creased so as to present angular faces, are said to make a superior heat-insulating material. It can be applied to both flat and cylindrical surfaces, and is suitable for use in cold-storage rooms, on boilers, steam pipes, etc.

The U. S. Bureau of Mines has announced its plans to study methods of extracting motor fuel from coal in anticipation of the day when our reserves of petroleum shall begin to decline. This and other research work in connection with coal is made possible by an added appropriation of $600,000 by Congress.

A machine has been devised for testing standard pipe fittings of various sizes and kinds at a rate of approximately 240 per hour. It ejects the good fittings on one side and the defective ones on the other, a recording instrument keeping count of both. Compressed air is used to do the testing.

At the plant of the Cerulean Stone Company, Cerulean, Ky., an abandoned steam hoist has been converted into a car puller and is said to be giving good service at low cost. Diesel engines having supplanted steam at that plant the hoist is being operated with compressed air, and is powerful enough to haul several cars at a time.

Linseed oil, we are told, is converted into a drier for varnishes by a new process developed in Germany. The oil is heated and aerated, about 106 cubic feet of air, or a corresponding volume of oxygen, being used per 220 pounds of oil. The resultant product is solid when cold and soluble in hot drying oil or oil varnishes.

Link Belt Company has developed a machine for placing ice on top of produce in refrigerator cars, work that is commonly done by hand. The unit crushes the ice and blows it forcibly to every part of a car—the small particles sifting down between the crates and boxes and serving more effectually to pack the ice around them and to keep their contents cool.

A new window glass, consisting of so-called "glass silk" sandwiched between two panes of ordinary glass, is being manufactured by a British concern and had its first application in one of the Vatican buildings. The core of finely spun glass threads is said to diffuse the light evenly and to permit the passage of the health-giving ultra-violet rays. The glass can be produced in a wide range of colors.

Something new in foundry developments is a casting faced with an abrasive material. This is made, according to the patentee, by covering the mold surfaces first with a solution of graphite and molasses water or clay and water and then with the abrasive material, both being applied by the spray method. The molten metal when poured fills all the minute interstices of the abrasive, thus making it an integral part of the casting.

A new motor oil containing minute quantities of tin and chromium in solution is said to have shown a 50 per cent reduction in cylinder wear, according to the National Physical Laboratory of England which has recently subjected it to exhaustive test. It is reported that the metals virtually plate the working parts of the engine and protect them against corrosion, which has been proved to be one of the main causes of cylinder wear.

Trees and shrubbery as a means of making night driving pleasanter and safer are an innovation in Germany's new *Autobahnen*, speedways. Their two 25-foot traffic lanes are separated by a 15-foot-wide strip where trees and bushes are planted not only for the sake of beauty but to shield the motoring public from glaring headlights. The present construction program calls for 5,000 miles of these highways, of which 1,000 miles have been completed.

Travelers who have occasion to use the new Pennsylvania Station in Newark, N. J., will do well to observe the great window over the Market Street entrance, for it is glazed with marble instead of glass. The substitution was made by the architects not alone for the sake of beauty but for comfort as well, as the thin slabs of marble will let in light and keep out glare and heat. The window is the result of considerable experimenting, and consists of fifteen panes of Alabama Madre cream marble each ½ inch thick and measuring 3 feet 3 inches by 3 feet 4 inches. The inner surfaces of these panes have been tinted a light yellow to harmonize with the interior decorative scheme of the station.

Wheeler Osgood Sales Corporation is offering a specially processed wood for concrete forms that has the name of Laminex Plyform. The product is claimed to be smooth, light, rigid, and resistant to climatic conditions, and its laminated cross grain makes it proof against warping and splitting and permits the use of fewer and smaller nails in the construction of the forms. As many as 22 have been built of the same material, but the average is said to be from four to ten. The material can be had waterproofed to keep out moisture and to increase slippage.

A ROCK-DRILL SCHOOL

A foreman in a CCC camp in the Grand Canyon area of Arizona is showing enrolled men the structural features of the "Jackhamer" and instructing them how to operate that machine. The two R-39 drills illustrated are being used to excavate a trench for a sewer extension. The photograph is reproduced through the courtesy of the Director of Emergency Conservation Work.